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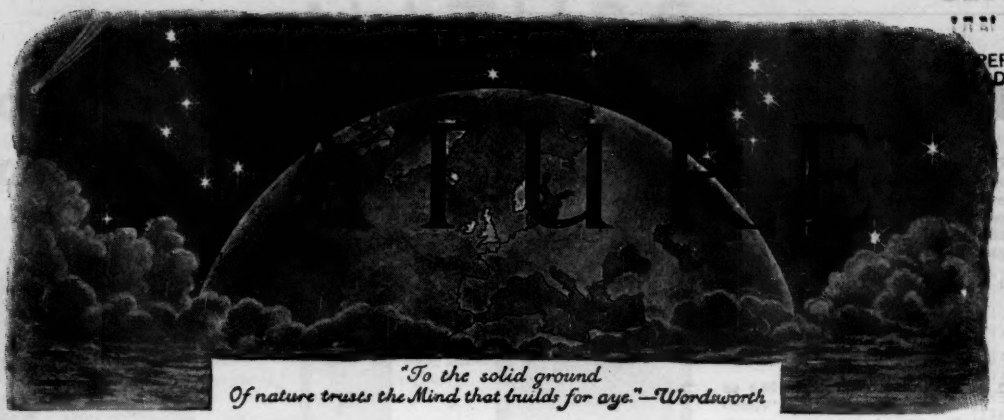

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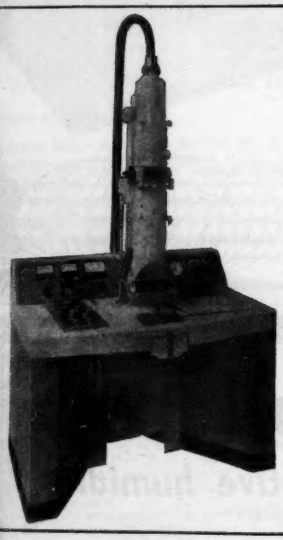

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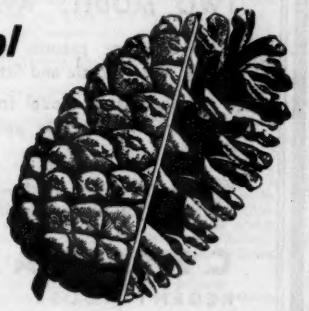

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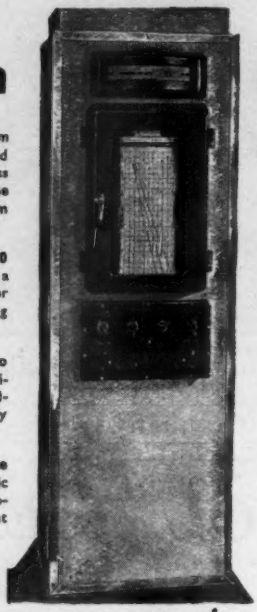

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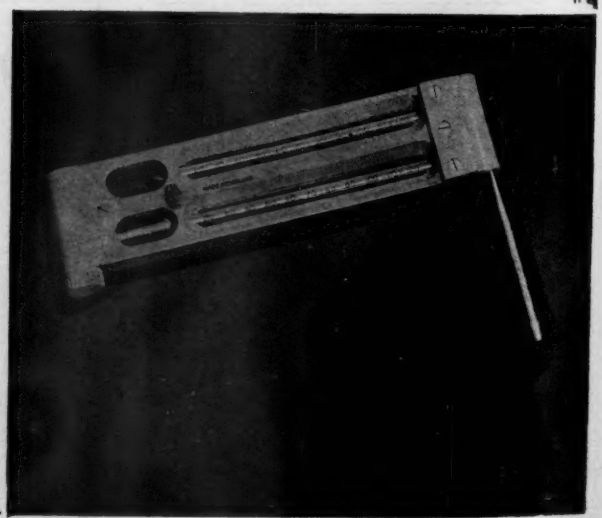

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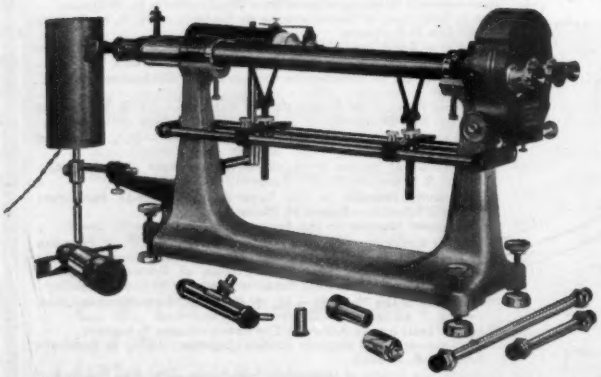

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EDUCATION FOR MODERN NEEDS

IN the House of Commons on May 22, Mr. Michael Stewart urged that a fresh inquiry into the way in which the universities of Britain are meeting the varied and changing needs of the community is appropriate, and he suggested for this purpose the appointment of a Royal Commission as the best means of arriving at an informed and impartial judgment to which the universities could pay due attention without loss of dignity or detriment to academic freedom. Mr. Stewart gave as one reason for holding such an inquiry at the present time, the increased need for university graduates, especially in mathematics and the natural sciences. Graduates are also required in administrative work, and this point has been emphasized increasingly in recent months in respect of management, particularly in relation to automation, and the whole field of what is loosely described as industrial or human relations. Furthermore, the increasing dependence of the universities upon public funds, both directly, through those distributed through the University Grants Committee, and indirectly through the various types of awards from public funds which a majority of students now receive, have changed the relation of the universities to public bodies compared with a generation or two ago. There is also, he said, the profound influence which the universities exert over the whole educational system of the country, but more especially over the secondary schools through the examination system.

All this, as Mr. Stewart quite rightly pointed out, gives the community a deeper interest in the way in which the universities undertake their work, and it might well have been added that the maintenance of academic freedom itself depends on the effectiveness with which the universities are able to bring home to the community as a whole both the nature of their task and the essential conditions for its efficient performance. Unless that is clearly understood, neither the funds nor the freedom for their proper use are likely to be forthcoming. That is not necessarily to agree that a Royal Commission is the most useful means of interpreting the work of the universities, either to Parliament or to the community in general, though a Royal Commission might well prove a more effective instrument in securing answers to some of the questions to which Mr. Stewart suggested it might address itself than some other bodies that have handled them.

In the first place, Mr. Stewart suggested that we might seek to form an estimate of the proportion of the population of Britain which should enter the universities, bearing in mind the needs of teaching, industry, the professions, the departments of State, commerce, etc., and considering such evidence as we can obtain from the schools and elsewhere as to the proportion of school-leavers likely to benefit from a university education. On neither approach would it be wise to dogmatize; but a sound judgment of the probable approximate proportion of the population capable of profiting by a university education is a fundamental condition of the wise expenditure of public funds on the expansion of the universities as well as of technological and technical education. Secondly, there is the removal of obstacles which at present prevent those who could profit from a university education from entering a university, whether the obstacles be of finance or of sex. Thirdly, Mr. Stewart suggested—and reasonably enough from the point of view of expenditure of public funds—that some inquiry is called for to consider wastage at the universities. If students are to make the best use of their opportunities there and an excessive proportion of failures is to be avoided, questions of selection as well as of teaching arise, and these are matters for expert inquiry. The recent report of the Committee on Halls of Residence hinted at the opportunities for experiment which lie in this field.

Mr. Stewart also suggested that the Commission might well consider what kinds of university we need, what range of pattern the university system of Britain ought to display and particularly as regards the distribution of undergraduate and postgraduate students. It could well arise, for example, in regard to university policy in relation to halls of residence, in order that the resources available for any foreseeable expansion are to be used to the maximum advantage. Here above all, however, there must be some clear conception of the answer to be given to Mr. Stewart's final question, as to the real function of a university, before sound decisions can be taken; the comparative survey of the systems of all Western European countries, which Sir Henry Tizard suggested at the British Association conference at Leeds last July, on the supply of trained men and women might throw some light on this problem.

It was suggested, indeed, by Mr. Stewart that one of the real reasons for such a commission of inquiry is that the time has come to ask afresh what is the real purpose of a university, and while he recognized that it is part of the duty of a university to meet the vocational needs of the community, he reminded the House that it is also part of the duty of a university to hand on to the next generation standards of values and beliefs on which our civilization rests. Does the vocational work of the universities to-day hinder the performance of that duty of transmitting our cultural heritage? Are the universities themselves satisfied that they can still effectively fulfil that cultural purpose?

Whatever answers the universities themselves may give to such questions—and they may well, and with advantage to the community, vary from one university to another—the universities are liable to be under some external pressure from the Government or local authorities and from private benefactors if

there is no general understanding and agreement as to their function. Apart from this, our conception of the purpose or function of a university largely determines decisions taken on practical questions which have been closely debated in recent months. That of halls of residence has already been mentioned. General education is another, whether in respect of the schools themselves or the nature or content of university courses. Training for management is a third; and the distribution of our resources between the universities, the colleges of technology and the technical colleges—the whole structure of technological and technical education—is ultimately determined by our idea of the place and purpose of a university.

A number of the questions that Mr. Stewart proposed are in fact already being examined. Besides the inquiry into halls of residence, a preliminary inquiry into applications for admission to universities has already been commissioned by the Committee of Vice-Chancellors and Principals of the Universities. Other questions have been touched upon in the course of an inquiry made by Political and Economic Planning, and sponsored by a joint committee of the Department of Scientific and Industrial Research and the Medical Research Council, into British industrial policy and practice in the recruitment, training and employment of university graduates, although PEP has had reluctantly to postpone, because of shortage of time and staff, a further inquiry into the views of the universities on the whole question of education for industry. Meanwhile, it is true that a closer and fruitful partnership is developing between industry and the universities, and a series of conferences arranged by the Federation of British Industries has contributed notably to a closer understanding by industry of university work and functions. Again, the Nuffield Foundation is sponsoring some investigations which should help to improve the professional training of the university graduate and the effectiveness of science teaching, both at school and university, as well as a study of factors which affect the supply and training of scientists, in particular of the difficulties which seem to exist in the full use of both graduate and non-graduate women in scientific and technical employment. Mr. Stewart also stressed the importance of making full use of women and seeing that those capable of profiting by a university education had the opportunity of getting it.

Whether or not a Royal Commission is the proper means, some support for Mr. Stewart's proposed inquiry can be found in many current discussions. Sir David Anderson's presidential address on education and training for the engineering industry to Section G (Engineering) at the British Association meeting at Dublin made a useful attempt to present a balanced picture in respect of one particular occupation. Without dealing with actual numbers, Sir David emphasized the importance of the sub-professional groups, including technicians, supervisors, foremen and skilled workers in making full use of the professional groups, and of the need to assess the relative contributions which technical colleges and the universities will make in supplying the engineering industry with trained men. Moreover, he pointed out that the industry is in keen competition with other industries and professions, and he was not too optimistic as to the extent to which we can increase the numbers in the professional groups. The chances of securing 20,000 graduates in science and engineering in Britain in the next ten years he regarded as slender. The major increase would come, he believes, from the technical colleges, because these institutions are linked with the stream of part-time education, in which there is an appreciable reserve of good brain-power, which could be selected and transferred to full-time courses. Unless considerably more young people show an interest in science, it is doubtful, he thinks, whether there is any appreciable reserve in the grammar and secondary schools for direct recruitment at sixth-form level. This, of course, confirms the importance of the studies which the Nuffield Foundation is sponsoring; but Sir David is convinced that the conferment of degree-granting powers on some of our leading technological institutions would greatly encourage young people to choose technology as a career.

Sir David also touched on the question of liberal studies in technological courses, and here again he indicated the scope for inquiry without attempting to offer a solution, though he believes the difficulty is exaggerated. Furthermore, he reminded us that the first-class thinker is rare. Most students have only moderate thinking capacity; and too much should not be expected from changes in teaching methods. The capacity to think, he remarked, is an inherent quality of the mind, and is probably much influenced by the way knowledge is presented and acquired. Nevertheless, the staff college for teachers recommended by the Willis Jackson Committee on Teachers for Technical Colleges might well make an important contribution by investigating this problem. On management studies Sir David's remarks ran largely with those in the PEP report; but he was emphatic that British industry should make a serious examination of the apprenticeship system. While the technician group does not appear to present any serious educational problems, he found it disturbing to reflect that in Britain a youth could become a skilled craftsman without having attended a single class or passed a single examination in the whole five years of his apprenticeship.

Sir David made several suggestions for co-operation between educational institutions and industry, largely on lines already emphasized in the PEP report. The importance of his address in this connexion is that it illustrates what is required generally, and not only in respect of engineering, though it by no means follows that inquiry by Royal Commission is the best means of collecting the further facts required or securing the necessary action. So far as co-operation or co-ordination is concerned, it might well suffice if some modification were made in our existing arrange-

ments, and particularly in those relating to the universities and higher educational institutions.

In the first place, while the Advisory Council for Scientific Policy has from its establishment been concerned with the supply of scientific and technical man-power and has made during the past ten years various recommendations both for increasing that supply and for ensuring the more effective use of the existing resources of trained man-power, those recommendations have in large measure been disregarded. A prime measure of responsibility lies on the Lord President of the Council, particularly in respect of the utilization of scientific and technical man-power and of the demand for that man-power. Responsibility also rests between the Chancellor of the Exchequer, so far as the University Grants Committee is concerned, and the Minister of Education. Even so far as higher technological education is concerned, responsibility is divided between these two Ministries.

If the recommendation that responsibility for higher technological education should be placed unequivocably on the University Grants Committee or an analogous body for technological education had been given effect, it is improbable that we would have witnessed the diffusion of resources which has resulted in one of the major colleges of science and technology being compelled to cut down its plans for expansion, while plans are in train for the upgrading of institutions the fitness of which has yet to be demonstrated to the Minister of Education. Probably only an inquiry with the authority of a Royal Commission could establish convincingly the waste of resources inherent in some of the proposals of the White Paper on Technical Education; a fresh recommendation from a body of that standing would perhaps secure the control and co-ordinated planning that is required.

Technological education, moreover, has to be planned in relation to university education as a whole and to technical education, as well as in relation to the numbers and abilities of the school-leavers which secondary and grammar school education provides. Britain's needs in this respect can only be ascertained with the assistance of industry, and here the Ministry of Labour, as well as bodies like the Federation of British Industries, could do much to help. What is needed is not so much new bodies as the wise and determined use of existing means of collecting the information. Nevertheless, to secure that the information as to requirements of technical man-power, its relation to those for graduates of all types, and to the available resources of school-leavers is properly presented to the right quarters may well demand some changes. It is not simply a matter of seeing that the expansion of university education, technological education and technical education is planned in step, but equally of seeing that no opportunities are missed of guiding the school-leaver into the careers where there is most need.

This is only partly a question of public relations. It is essentially a question of balance, and here we touch on the vital question of the purpose and function of a university. No sound relation between university and technical education can be established without clear ideas as to the function of a university. This lies, too, at the root of the whole discussion on general education, what it should mean to-day and where it should be given. Unless it is given due attention, there is real danger that our plans for expanding university and technological education will fail to provide the scientists and technologists or art graduates equipped to live in the modern world.

Industrial leaders like Sir Alexander Fleck and Mr. A. D. Bonham-Carter, scientists like Sir John Cockcroft, have made it clear enough already that what industry is asking of the universities is a supply of graduates, in whatever faculty, who can think and act for themselves, capable of choosing between truth and falsehood, wisdom and folly, beauty and ugliness; nor can it be suggested that the State, the public corporations, local government and commerce need men and women less qualified in these respects. It may, of course, be necessary to revise our estimates of the numbers capable of profiting by a university education or its technological equivalent. There may be fresh ideas as to where technological education should be given and about the quantitative balance between technological and technical education. The content of university courses may need revision—to serve not simply vocational needs but also the cultural and human requirements of society—in accordance with our concept of the purpose of a university. Our ideas of the standards of accommodation at the universities may also need revision in this light. It might still prove possible, for example, to extend considerably our halls of residence without diminishing their cultural and general educational influence while heeding Mr. Stewart's plea for frugality.

What is most disturbing at the present time is, as the report "Industry and Technical Progress" emphasized, not the shortage of trained men and women, but the lack of evidence that effective corrective action is being taken, even to secure the further information needed as to the relative demand for particular categories and as to the more efficient use of scientific and technical staff—and probably professional staff generally—in industry. Moreover, this should be considered in view of the opinion expressed in the report that there is little likelihood of increasing appreciably the supply of really first-class minds, although in the middle ranks there is not sufficient evidence that the limits of the potential supply of able minds have yet been reached. Again, so far as the universities are concerned, the extent of their response to the national demand for more trained man-power is conditioned by the magnitude of the grants they receive from the Government; yet when those grants are halted or reduced in the name of economy, the Government fails to concert the measures required to secure the most efficient use of existing man-power, whether they be measures to keep the supply of different types of trained man-power in balance, to ensure that a

sufficient supply of supporting technicians is available, to reduce the wastage of potential ability from the schools or in other ways, or to foster the information services and the national library system upon which that efficiency so largely depends.

It is not right to suggest that the universities of Great Britain are indifferent to the problems of fitting students for life in the modern world. The recent suggestion of the General Board of the Faculties of the University of Cambridge for a new Tripos examination, and Sir Eric Ashby's May Lecture to the Institute of Metals on "Technological Humanism" are examples of how university circles are prepared to consider ways of meeting these problems. Much, however, that remains to be done must fall on the professional institutions and learned societies and on industry itself, particularly in regard to the efficient use of existing man-power and in indicating the extent to which the supply of particular categories should be expanded. Nevertheless, the major contribution must come from the Government side. Neither the plea for further thought about the functions of the schools, the technical colleges, the colleges of technology and the universities in the light of the deeper question: What is the end and aim of a human life? nor the progress already made in the expansion of technical education or in co-operation between industry and the universities, should be allowed to distract attention from the shortcomings of the Government in these respects. The simple truth is that Britain's investment in her schools and technical colleges and universities is the surest safeguard of her future. It must be maintained and expanded to the limits which the inquiries adumbrated indicate, whatever the sacrifice to be made elsewhere in other social services or in the resources lavished upon recreation and amusement.

THE UNIVERSITY OF CALCUTTA

Hundred Years of the University of Calcutta

A History of the University issued in Commemoration of the Centenary Celebrations. Pp. xxi+539+258 illustrations. (Calcutta: The University, 1957.) Rs. 25.

UNIVERSITY histories are difficult both to write and to read. Piety demands a detailed record of professors and departments, of benefactors and officers, which is mostly of only local interest. It is difficult, through that mass of material, to display, or to grasp, the main themes of the story. Calcutta's centenary volume attempts it in the form of eight chapters, written by eight members of its staff, and although there is some overlap and some discontinuity, and catalogues cannot be entirely avoided, yet themes are conspicuous and they remain distinct.

Higher education on a Western model began in India a century and a half ago, in the form of sporadic colleges, some private, some with Government support. The first University was that of Calcutta, established in 1857 as an examining body, which affiliated colleges to itself, conducted entrance and degree examinations for their students, and thereby exerted an important but external influence on their teaching. Not until half a century later did it become a teaching institution itself and then only at graduate-level and in certain professional schools. Its 80,000 undergraduates are to-day still mostly in affiliated colleges. To adjust the relations between University and colleges has been a major and continuing problem. So also has been the relation between University and Government. The University, like some of its colleges, was a Government creation, largely Government managed. Too much Government control, in the pre-1947 years, was seen as foreign domination, but also as a limitation of academic freedom. In 1923 it was dramatically, but unsuccessfully, resisted, at a time when the University had weakened its own position through getting into financial difficulties; its famous vice-chancellor, Asutosh Mookerjee, then scornfully rejected Lord Lytton's offer to re-appoint him for a further term, because the offer was coupled with a condition that he withdraw his opposition to the Government's University Bill. The University is still more a subject of the Government than a partner with the Government, but a step towards responsible independence was taken in the Calcutta University Act of 1951, which recast the constitution and re-organized the administration.

Burdened on one hand by so large a brood of foster-children (there are now 123 colleges), and hampered on the other by severe financial limitation and close dependence on the Government, the University has nevertheless struggled to achieve good academic standards. In the work of its best scholars and in its development of research it has had undoubted success, but at undergraduate-level the recent flood of students has overwhelmed it. "There is hardly any doubt that the gain in quantity has been offset by the loss in quality. The mechanical examination system, defective teaching, expenses of education, decline of the middle class and many other factors are responsible for the fall of standard." So writes the author of Chapter 8; and the Vice-Chancellor in his crisp foreword, recognizing this situation, is much more concerned with the task of the future and the restoration of standards than with casting his eye over the past. So, among the handicaps, complacency is not one, and therefore in spite of the dismay that strikes the insular English visitor at the sheer size of the place and its problems, we may expect the University of Calcutta in its own way to find the answers, and to maintain the place of respect which it holds among the universities of the Commonwealth.

Robert Aitken

INFECTION BY ANAEROBES

Biologie des Maladies dues aux Anaérobies

Par A. R. Prévot. (Collection de l'Institut Pasteur.) Pp. 572. (Paris: Éditions Médicales Flammarion, 1955.) 2,225 francs.

THIS book can be regarded as a continuation of the classic treatise of Weinberg, Nativelle and Prévot, "Les Microbes Anaérobies", which gave a comprehensive survey of the anaerobes and infections caused by them for the period 1877–1937. The present volume carries on where the earlier one left off, and deals with the period 1937–55.

In the admirable introduction the author explains the purpose of the book. The main emphasis is on

the application of biological principles rather than on clinical details. Great importance is attached to the ways in which increasing knowledge of chemical microbiology, of serology, of pharmacology ('physiopathologie') and of histopathology has advanced our understanding of the lines on which control of these infections can be achieved.

The first half of the book deals with 'exogenous' diseases caused by toxigenic anaerobes—tetanus, botulism and 'gangrenes'; the second half with 'endogenous' diseases caused by virulent but non-toxigenic organisms such as anaerobic cocci, fusiform bacilli, actinomycetes and others.

The first chapter is on tetanus. This is considered under the heading of bacteriology, toxin, anatoxin (toxoid), spontaneous and experimental tetanus, immunology, and finally treatment. The evidence on the route of transmission of the toxin is fully discussed, and great importance is attached to the decisive work of Payling Wright and his colleagues which has cleared up a number of controversial points. In a later section there is an interesting table showing the downward mortality trend for tetanus in France since 1943. The author points out that, in spite of this downward trend, tetanus with 577 deaths in 1953 killed nearly two and a half times as many people in France as poliomyelitis. In spite of all the advances in our knowledge tetanus still has an appallingly high mortality, varying from 50 up to even 90 per cent.

The chapter on botulism follows the same general plan. Here again, although we have learned a great deal about the biology of botulism in the past eighteen years, we still have no really rapid means of making a diagnosis before it is too late, and serum treatment, even though more effective than serum treatment of established tetanus, often fails.

The third chapter consists of several sections dealing with the different groups of *Clostridia* associated with gas gangrene and similar infections. The biochemical aspects both of the organisms and of their toxins are fully reviewed, and the work of Evans, van Heyningen, M. G. Macfarlane, R. G. Macfarlane, Miles, Oakley and others, is well discussed.

Part 2 of the book deals with the infections caused by 'endogenous anaerobes'. These infections are quite different from the intoxications dealt with in Part 1. The organisms live normally as saprophytes in various animal or human tissues and become virulent when there is a breakdown in the natural defences, when they provoke first a focal infection and later perhaps a generalized infection spread by the blood stream to distant parts of the body. Many of the organisms in this group are rare and little known; others are fairly common and well known, but the nomenclature used by Prévot, though generally recognized by Bergey, is by no means familiar to all bacteriologists. It would have been very useful to have a comparative table setting out the various alternative names for such words as *Ristella*, *Spherophorus*, *Zuberella*, etc., and to see side by side a few at least of the commonly accepted alternative names.

The book contains about 2,300 references. Since it covers a period of eighteen years, this represents an average of 127 publications each year. The author compares this with the average output of sixty each year in the earlier work. References are given at the end of each chapter or main section. It is a pity that authors' initials are not given. At best the omission is trying, at its worst it may be confusing as, for example, with the name Macfarlane, which in addition is spelt wrongly both in the text and in the bibliographies. The system of arranging references first under the appropriate year and then in alphabetical order has much to recommend it.

The book has achieved admirably the author's declared purpose—to give a comprehensive review of the biology of anaerobic infections from 1937 to 1955, and must be regarded as a standard work of reference on this interesting and still intricate branch of bacteriology.

R. KNOX

EXECUTIVES IN INDUSTRY

Promotion and Pay for Executives

By Dr. George Copeman. Pp. 219. (London: Business Publications, Ltd., in association with B. T. Batsford, Ltd., 1957.) 18*s*. net.

FOR the scientist, the world of industry and commerce has long seemed to portray all the features of a dark impenetrable forest; its paths overgrown with tangled roots and creepers; its overhead foliage precluding the light of knowledge; its deeper recesses possibly hiding fearsome monsters. To launch one's life into so unknown and incomprehensible a domain could be hazardous in the extreme, and—more serious—could in the end turn out as a futile and unrewarding journey. So the scientist has sought his career in more readily appreciated territories.

Yet industry to-day needs the scientist almost more than anything else, and service in industry can afford to him a career with objectives of high national, social and professional purpose. A genuine barrier to entry into such service is found in the ignorance of opportunities—not so much in the sense of not knowing where the openings lie (for this gap in knowledge has been amply filled in recent years), but in lack of the means of assessing potential lines of advancement and the monetary rewards for high performance. Dr. Copeman's study is the first serious contribution to filling in that gap—hitherto only inspectors of taxes have known the secrets of financial advancement in terms of real sums of money.

Dr. Copeman's book, it is true, is no more than a minute contribution, for the sample of fifty executives is infinitesimal, and among these the proportion of scientists is very small. But this should not belittle the real value of the contribution. Its form is a series of detailed career patterns of a "fairly representative sample" of executives from different industries, in different localities, of varying ages, and ranging in present salary from £1,100 to £15,000. The data are reliable, for they are based on personal individual interviews, with guaranteed anonymity. For the benefit of those who enjoy comparative reading, the data are given in tabular form, concisely distributing the fifty specimens in terms of age-groups and salary-range. No general lessons are deduced, nor could they be; but the serious reader can draw for his own guidance useful ideas as to possible levels of salary and promotion, relative to age and length of service, in reasonably typical industrial environments. In no sense of the term is this study 'scientific' but it could be found of genuine practical value by many a qualified man attempting realistically to assess his prospects of fortune in an industrial career.

A second half of the book goes into more intangible realms, with chapters on "Qualities of Leadership", "Organising", "Ideas", "Frustration", "Seeking Promotion". Here the author has endeavoured to synthesize the views expressed by his fifty high-level 'guinea-pigs', with an added measure of his own interpretation. Here his study is correspondingly more open to argument, to disagreement and to scepticism. Inevitably, the range of views on any one topic is wide and diversified; the author's own interpretative synthesis has offset the mutually contradictory elements, and he has tried to emphasize the practical value of his findings by a brief summary of points at the end of each chapter. Yet their very succinctness posits superficiality. To the novice on the brink of a career they may well serve as the modern counterpart of the once-famous Dale Carnegie aphorisms on self-advancement; to the serious and established reader they may perhaps usefully serve as reminders—a simple guide to checking whether executive responsibilities are being competently and constructively discharged. Objective and permanent values apart, in all the aspects covered the study makes interesting reading. E. F. L. Brech

MECHANICS OF ELECTRONICS

Mechanical Design for Electronics Production

By John M. Carroll. Pp. xx+348. (London: McGraw-Hill Publishing Company, Ltd., 1956.) 49*s*.

IF we were to represent the activities of those engaged upon the development and application of electronic equipment by a Gaussian distribution, we would see a few advanced designers and specialists rising above a wide base of detailers and technicians.

Among these 'other ranks', there will be few who would not benefit by a perusal of the present volume. So much detail must usually be delegated to others that it is most desirable to have a wide dissemination of knowledge of good current practices.

The circuit and system designer who can find time to study this book will uncover much food for thought, particularly concerning production processes, where some of the details given are unlikely to be known to those who have not had considerable experience in a number of the departments of a modern factory. The relation between system or circuit sub-division and modular construction is presented particularly well.

A high standard of mechanical construction is essential to-day for military equipment, and in wave-guide systems a high degree of precision is required. These standards are not always found in laboratory-constructed equipment, and manufacture from the resulting 'prototypes' may be delayed by a further phase of production engineering which could be avoided or carried out at an earlier stage.

The organization of this book is interesting, as a method of putting forward up-to-date and comprehensive information in a field subject to rapid changes of technique. The author first published the material as a group of articles on mechanical design in the journal *Electronics* late in 1954, the contributions being made by some fourteen mechanical engineers experienced in the electronics industry.

As now published in 1956, the material has been re-arranged as chapters, and brought up to date with respect to mechanized assembly methods, automatic testing and materials. The references are mainly to sources and proprietary names known in the United States, but a British reader will not find himself handicapped appreciably. The book could have been prepared from British sources, but it is doubtful if we have the editorial resources to execute it.

The contents cover a considerable field in adequate detail, with much reliance on photographic illustrations of processes and line drawings of mechanical design details. Attention is given to the importance of mechanical design, and to the space-planning of equipment layouts. Chassis layout is dealt with in detail.

Processes used in the fabrication of cabinets, chassis and small parts are described rather fully, wiring and soldering are dealt with, and components and assembly methods described. Useful technical information is provided on mechanical design details, rotary machines, materials and environmental factors.

D. L. Johnston

NEAR-EASTERN ADVENTURES

Adventures in the Nearest East

By Cyrus H. Gordon. Pp. 192+23 plates. (London: Phoenix House, Ltd., 1957.) 25*s*. net.

THIS is a very readable book. It has not been written for the academic specialist who requires all the details carefully documented, but in a pleasant manner it conveys a lot of interesting archæological information. The author knows what he is writing about and the result is a correct account of what he himself has seen and studied. For example, the chapter on the Dead Sea scrolls is an admirable account of the finds and their significance, though it is not intended to be in any way a detailed study of these important discoveries. Interspersed with the account of his journeys and digs, he gives us stories of such everyday trifles as how he had to play the part of an amateur doctor or oculist.

Prof. Gordon opens by telling his readers of his journeys in Edom and Moab, a land still little known, even under its new name of Transjordan. Other chapters deal with accounts of digs and of finds of works of art. The Ugarit Kingdom, which flourished during the Bronze Age in northern Syria, is still little known to the average archæologist; yet it is of considerable importance. There a number of tablets have recently been unearthed, the language being akin to Phœnician and Hebrew. Many of the texts are mere business documents, others are of a ritual nature. A number record poetically the lives of the North Canaanite gods whom the Israelites are forbidden in the Old Testament to worship. But there appears also in some of these texts the indication of the beginning of an ethical religion such as we do not find again until it reappears wth the early Hebrew prophets of the eighth century B.C. A chapter on the military correspondence of the last days of Judah gives a useful commentary on the immediately pre-exilic period there, and should be read alongside the Old Testament story. Final chapters deal with "The Fathers of Egypt" and "A World of Demons and Liliths". The work is well illustrated, and there are at the end a number of notes and a short bibliography. Many people, both archæologists *de métier* and interested amateurs, will read Prof. Gordon's book with pleasure and profit. M. C. Burkitt

Physiopathology of the Reticulo-Endothelial System

A Symposium organized by the Council for International Organizations of Medical Sciences. Edited, under the direction of B. N. Halpern, by B. Benacerraf and J. F. Delafresnaye. Pp. xii+317. (Oxford: Blackwell Scientific Publications; 1957.) 45*s*. net.

IT is greatly to the credit of Dr. Bernard Halpern and his colleagues that this symposium was organized and its proceedings compiled.

Generally speaking, the reticulo-endothelial system has not made sufficient impact on the medical world and its significance and importance are more or less poorly understood. A monograph of this kind containing formal papers, as well as summaries of discussions, is of special value since it shows the manner in which research results were studied and compared by investigators from different countries. It brings to light many factors of the physiology and pathology of this system applicable to the clinical field. Three of its important functions were specially studied—its phagocytic activity, its metabolic functions and its role in defence against bacterial infection. It was shown that phagocytic activity is influenced by the size of the liver and spleen, which are the main phagocytic organs, the volume and velocity of blood flow, the functional state of the phagocytes, and the chemical constitution, size and number of the particles of injected substances. Evidence was also presented indicating that the reticulo-endothelial system is also concerned with the elimination of blood cells, with iron and fat metabolism, with the formation of antibodies, with the production of fibrosis, and with the removal of bacteria from the circulation. It appears to be the most efficient line of defence against bacteræmia.

It is surprising, however, that no direct reference has been made to the influence exerted by the steroid hormones, which have been found to be the greatest stimulants of reticulo-endothelial activity. Further, in our laboratory vitamin B_{12} and choline were found to be mild depressants and not stimulators, as here reported.

This symposium has been a valuable contribution to research on the reticulo-endothelial system and provides the most up-to-date account of the subject available. It is hoped it will be followed by many others in this important field of investigation.

T. NICOL
D. L. J. BILBEY

A Bibliography for the International Geophysical Year

National Science Foundation. Pp. vi+51. (Washington, D.C.: Government Printing Office, 1957.) 25 cents.

THE foreword to this bibliography states that it is neither definitive nor selective, is imperfect in many respects, and consists, for the most part, of discrete articles, the majority of which are of a non-technical nature. The reviewer can only emphasize the fact, implicit in the quoted description, that this bibliography is inadequate for the needs of the scientist professionally concerned with the International Geophysical Year. A large number of the 600 or so articles listed consist of popular articles in American magazines.

Thirteen of the 37 bibliographical pages are devoted to Earth satellites, but even in this subject it was easy to think of a scientific article, one published in *Tellus* in 1956, which was not included. Articles in the scientific press of the U.S.S.R. are not listed, reports of Russian work being almost entirely limited to press releases from the Soviet Embassy in Washington.

Besides the bibliography there is a general account of the administration of the International Geophysical Year, and a comprehensive list of members of the U.S. committees concerned with it.

G. A. BULL

Forest Fungi

By Margaret E. Lancaster. Pp. 96. (Wellington: Government Printer, 1955.) 9*s*. 6*d*.

THIS attractively produced book, designed as a fairly elementary manual on forest mycology for use of the field staff of the New Zealand Forest Service, is disappointing in several respects. With such a title and so few pages, one does not expect a third or so of the text to be devoted to an account of elementary botany and an outline classification of the plant kingdom.

In the preface, the statement that "It is apparent that a basic understanding of the broad essentials of growth and reproduction of all plants is a prerequisite for even a cursory study of such a specialized group as the fungi" is, broadly speaking, true, but it was unwise here to waste space in attempting the impossible. The remainder of the book deals with the classification of fungi generally and gives a summary of the individual families with special attention to those including representatives pathogenic to trees. This is a fairly good text-book outline, well illustrated, but, in spite of a full glossary, much beyond the comprehension of the type of student for whom it is apparently intended. In compiling it the author has occasionally nodded through making generalizations. A few minor errors have been corrected in an inserted errata slip. One of a kind which haunts proof-readers, *Dictyota* for *Dictyophora*, should be added—and *Eurotium* is the perfect stage of *Aspergillus*, not of *Penicillium*.

J. RAMSBOTTOM

Species Studies in the British Flora

Edited by J. E. Lousley. (Botanical Society of the British Isles Conference Report No. 4.) Pp. 188. (London: Botanical Society of the British Isles, c/o Department of Botany, British Museum (Natural History), 1955.) 20*s*.

THIS volume is the report of the fourth conference of the Botanical Society of the British Isles, held in London in 1954. These biennial conferences have become an important feature of the activities of the Society, providing an opportunity for the presentation and discussion of work on all aspects of the British flora. The present report contains twenty-six contributions, mostly of high scientific merit. It is unusual in including a number of valuable papers upon the problems of bryophytes and thallophytes, since the work of the Society is traditionally limited to vascular plants with a minor descent to embrace the orphan charophytes. The contributions are from botanists both amateur and professional, for the Botanical Society is one of the few remaining scientific societies in which amateurs and professionals continue to work actively and amicably together with mutual comprehension and profit. While productions as informative as this report continue to emerge, one is moved to hope the collaboration will long continue.

WETTING AND SPREADING OF LIQUID METALS ON SOLID METAL SURFACES

DEVELOPMENTS in modern science which open up new fields of academic and industrial activity also have a direct impact on the older, established applied sciences. These generally undergo a transition from empiricism to the development of the scientific basis of the subject. In most cases this transition has already taken place or is well under way, but it is only just beginning in the heterogeneous group of subjects, soldering, brazing, welding and the gas-cutting of metals, which comprises one aspect of the science of metallurgy. The demand of modern industry to be able to join an ever-increasing variety of metals and alloys by a multitude of techniques has resulted in a considerable expansion of research activity in industry, research associations and the universities. One hundred and forty representatives of these bodies attended a conference on "The Wetting and Spreading of Liquid Metals on Solid Metal Surfaces" held at the University of Birmingham on September 25 under the chairmanship of Prof. E. C. Rollason, head of the Department of Industrial Metallurgy. In his opening address, Prof. Rollason explained that it was planned to hold occasional conferences on various aspects of the joining of metals, of which this was the first. In this way the practical experience of industrialists could aid the University in deciding the direction of its efforts and further the formation of general principles which are important in the teaching of the undergraduate. In turn, the University hoped to provide a useful stimulus to industry by contributing another point of view. Four papers, by Mr. D. R. Milner, of the Department of Industrial Metallurgy; Mr. E. V. Beatson, of Joseph Lucas, Ltd.; Dr. J. C. Chaston and Mr. M. H. Sloboda, of Johnson Matthey, Ltd.; and Mr. A. Cibula, of the British Non-Ferrous Metals Research Association, were then presented and discussed.

The phenomena of wetting and spreading are of prime importance in the formation of brazed and soldered joints, and in practice often present considerable difficulties, while scientifically they require an interesting extension of classical physical and chemical principles to take account of the complexities and interactions which occur in practical systems. Thus, the well-known equilibrium surface tension theory which relates, first, the surface free energies to the interfacial energy and contact angle; and secondly, the pressure difference across a curved liquid surface to its radii of curvature and surface free energy, implicitly assumes no interaction between the solid and liquid and that the solid surface is plane and clean. In all soldering and brazing systems, however, there is some interaction which cannot be ignored. Mr. Cibula's paper was largely concerned with one of the most important of these, namely, alloying between the liquid and solid metal, which can become of over-riding importance at high temperatures. Thus, a liquid drop when placed on the solid surface takes up a shape dependent on the surface and interfacial free energies and then spreads out as alloying takes place, the rate of spread depending on the solubility of the liquid in the solid metal. However, marked alloying results in erosion of the solid metal and a considerable change in the properties of the liquid. Erosion is generally undesirable and may be controlled by using a mixture consisting of a liquid which has limited intersolubility with the solid and a small proportion of a more soluble metal. Increasing the superheat has a marked effect on the rate of spread as it increases the rate of alloying. A particularly important case of this kind occurs when the liquid flows over the solid and interacts to form an intermetallic compound layer at the solid surface greatly reducing its free energy, with the result that the liquid layer becomes unstable and 'dewets' by retracting into an array of isolated drops.

There are other forms of interaction and it has been shown, for example, that the surface tension of solid copper is reduced to less than half its 'clean' value in the presence of lead due to the absorption of lead vapour. When a flux is used, further interactions are possible; metal can be transferred from the liquid metal on to the solid surface by an electrochemical mechanism; surface energies can be altered by electro-capillarity forces and chemical reactions can take place between the flux and the metal. The latter is made use of in the so-called 'reaction fluxes' for the soldering and brazing of aluminium; these fluxes contain zinc chloride, the zinc being replaced by the aluminium and deposited as a liquid layer on the aluminium surface. Since zinc is much less readily oxidized than aluminium, wetting and spreading are promoted.

Oxide films are present on the majority of metals and have to be removed before satisfactory wetting can occur. Fluxes are often used for this purpose, but the exact mechanism by which they act is obscured by the lack of knowledge of the behaviour of molten salts. One thing is becoming clear, however: although fluxes may remove the initial oxide film, oxygen can still diffuse through to reoxidize the underlying metal and retard spreading and flow. An account of the particularly interesting case of the fluxing of stainless steel was given by Dr. Chaston and Mr. Sloboda. In this case the interaction with oxygen appears to be more complex than usual, as in some fluoride-containing fluxes the chromium is preferentially oxidized out of the surface layers, leaving a deposit of iron fluoride, which, having the relatively low surface energy associated with ionic compounds, gives rise to a large contact angle and poor flow of liquid brazing metal.

Mr. Beatson dealt with the two other common methods of removing oxide films, heating in a reducing atmosphere and heating *in vacuo*. The reduction of oxides by hydrogen or carbon monoxide has a sound thermodynamic basis and it is not difficult to derive the critical value for the dryness of hydrogen or critical carbon dioxide/carbon monoxide ratio above which the oxide cannot be reduced. Below this value, however, the kinetics of the system must be considered and no generalizations are as yet possible, other than that above 1,000° C. thermodynamically favourable reductions appear to take place within a reasonable period of time, while below this temperature an answer can only be given by resort to experiment. Perhaps the major limitation of the

thermodynamic approach is that at present it can only be applied to pure metals, whereas in practice it is generally necessary to consider alloys, which are sometimes very complex and often contain a proportion of a metal which forms a highly stable oxide. The use of atomic hydrogen for oxide reduction appears to offer interesting potentialities, as thermodynamically it is considerably more favourable. Since dissociation of molecular hydrogen at the metal surface may constitute a major part of the activation energy involved in oxide reduction, the kinetics may also be more favourable. In this connexion there is an interesting process which is finding increasing application to the frequently occurring problem of the construction of fine thermocouples. The thermocouple wires are twisted together and made the cathode of an electrolytic cell in which the electrolyte is 15 per cent aqueous sodium carbonate solution contained in an iron vessel which is the anode. A potential of 80–220 volts is applied to give a high current density and atomic hydrogen is freely liberated at the cathode, reducing any oxide, while the heat of recombination suffices to fuse the ends of the wires together.

The developing use of vacuum brazing illustrates the advanced techniques necessary in modern metal-joining practice. The use of vacuum or an inert atmosphere, generally argon in Britain and helium in the United States, is essential for the brazing of the highly reactive metals such as titanium, zirconium and molybdenum. The 'Nimonic' alloys, which are so important in the development of the gas turbine, are also frequently brazed in a vacuum. The manner in which a metal surface is freed from oxide by heating *in vacuo* is open to conjecture and various opinions were expressed at the Conference, such as solution of the oxide into the metal, or vaporization of the oxide film.

The analysis of the flow of the liquid metal into a joint under the influence of capillary forces presents considerable difficulty. A simple model has been set up in which laminar flow is assumed to take place, but although the size of the capillary passages and the velocity of flow are well within the limits for laminar flow under steady-state conditions, it is doubtful whether this applies to the 'once and for all' filling of a joint. Experiments made on the flow of solder into capillary passages between copper sheet and tinplate give an actual time of flow about twice that predicted theoretically. Mr. Cibula showed that at high temperature, unless special care is taken, the whole analysis becomes meaningless, because temperature gradients enable the liquid to flow all around the relatively hot periphery of a joint, giving a satisfactory-looking fillet but leaving the colder inner portion unfilled. Alternatively, alloying can occur, increasing the melting point of the liquid before it has time to enter far into the capillary.

The points raised during the discussion clearly reflected the preoccupation of those engaged in solving current problems. Thus the difficulty of maintaining the desired purity of hydrogen and predrying techniques when using production heating furnaces received some discussion; removal of water vapour and oxygen by zirconium or magnesium turnings within the furnace, and the use of the gases boron trifluoride and silicon tetrafluoride were all mentioned. There was considerable discussion of the problem of voids, which may occupy from 5 per cent to as much as 50 per cent of the total area in brazed joints, and in addition to non-uniform heating it was claimed that shrinkage or gas evolution on cooling, and incomplete oxide removal were all significant. The problem of the wetting of stainless steel and the 'Nimonic' alloys was raised by several speakers; the former can be solved by ensuring the use of adequately dry hydrogen and the latter by the use of a vacuum better than one micron. Difficulties associated with the other less widely used metals such as tungsten and molybdenum were also mentioned, but the range of applications and problems which are now confronting workers in this field was perhaps best illustrated by the representative of a firm manufacturing transistors, who stated that when 'brazing' germanium with indium, wetting and spreading were determined by the dislocation density and indices of the crystal face being brazed.

D. R. Milner

NUCLEAR ENERGY AND THE GROWTH OF MAN*

By Dr. ARTHUR H. COMPTON

Distinguished Service Professor of Natural Philosophy, Washington University, St. Louis

My prime concern is the urgency that availability of nuclear energy gives to world-wide co-operation in the cause of humanity. It is toward such co-operation that we must now look for the growth of man.

In the programme of 'Atoms for Peace', emphasis has been laid on the usefulness of the energy of the nucleus. This is as it should be. We are using this energy in the form of radiation for diagnosis and healing of disease. We are using isotopes as tools in science and industry. With the important steps already made, we see electric power from nuclear furnaces ready to meet a great human need for a long time to come.

Consider as an example the use of nuclear radiations in the art of healing. Such use began with the discovery of X-rays and radium at about the turn of the century. Estimates have been made of the effectiveness of these rays in diagnosis and therapy. These estimates are necessarily only approximate; but they do show this, that by the use of these rays throughout the world some tens of millions of lives have been saved. This number is roughly the same as that of the lives destroyed in all the world's wars fought since their discovery. In this way alone our concern with atoms and nuclei has opened to a great multitude of men and women more complete physical health and life.

But important as it is, here is not our prime point of emphasis when we think of nuclear energy and the growth of man.

* Substance of an address during ceremonies marking the presentation of the Atoms for Peace Award (*Nature*, 179, 698; 1957) to Prof. Niels Bohr at the National Academy of Sciences, Washington, on October 24.

The prime point is rather this: science and technology have provided us with unprecedented new powers. We are acutely aware that these powers can bring us either greater opportunity, or destruction and death. In this regard, nuclear energy is only one dramatic example of the new possibilities that science holds before us, possibilities for good or ill in truly startling measure; and the rate at which science is presenting man with these unprecedented powers is increasing at enormous speed. Furthermore, each such technical development multiplies the effectiveness of those that went before. This is a condition similar to that recognized in science as dynamic instability. We must expect the balance of world-power to be continually shifting as new technical advances, occurring in different parts of the world, make more effective the use of the strength already in men's hands. The stability of civilization itself is thus at stake.

Immersed in the immediate task of protecting freedom, we must not fail to look to the future. For a limited period we may hope to prevent war by keeping a strong and sure defence; and never was an alert defence more needed than to-day. But to bring stability among sovereign nations only one way is open. They must be united by some human goal worthy of their strength. There is no other hope for a peace that will endure.

If mankind is to prosper, if civilization is even to survive, it is necessary that steps be taken which will ensure that our new powers will not be used for destruction. We must turn them toward enabling men and women to grow. The time when we need the assurance of the human use of technical strength is now. Every day we delay constitutes a statistically significant lessening of mankind's chance for survival. I am not exaggerating. The seriousness of the dangers and the greatness of the corresponding opportunities are evident to all who have examined the changing situation of man.

What can be done that man's new-found strength will be used for building, not destroying, our civilization? This is the all-important question. Let me repeat: if co-operation is to replace antagonism among nations, it will come only as they agree upon some common objective which will inspire the whole-hearted support of their people. Such an objective cannot be one which places the interests of one nation above those of another. To be affirmed by all nations it must relate to the needs of all men and women.

There exists such an objective that during the past half-century has arisen throughout the world as a hope in the hearts of men. In the United States we have known this hope since before our nation was founded. We call it "the American Dream". Our vision is of a place where every man and every woman can grow to the best that is in them and be recognized for what they do to help others share this opportunity. Some years ago I showed to Mme. Pandit a description of this vision as written by our late historian, James Truslow Adams. "You call that the American Dream," she exclaimed. "It has become the dream of the world."

Let us examine the answer to our central question that this dream suggests. To state the proposal specifically, it is this. Let every nation affirm, as basic to its policy, this principle: that it will do all in its power towards opening the way for everyone under its jurisdiction to grow to his full human stature, and will co-operate with nations affirming and adhering to this principle in helping each other provide such opportunity for their people.

In accord with this principle, each nation that thus commits itself will endeavour to direct its own actions so as not to interfere with those of other co-operating nations in their efforts on behalf of their people. It will consult in advance before taking action that might affect adversely the plans of another co-operating nation. It will join with other such nations in defence against threats to any of them regarding its internal actions on behalf of its citizens.

The intent of the proposal is to turn the world's resources toward enabling men and women to become able and responsible citizens of their respective nations. Each nation co-operating to this end retains its sovereign right to choose its own method for providing its citizens with increased opportunity. Each can also count on the help of the others in providing and defending these opportunities. Can a government, the prime responsibility of which is the safety and welfare of its citizens, agree to a policy that has in it so much of altruistic content?

In answer we note that every nation's safety and welfare require assurance of co-operation by other nations. On no lesser objective than opening the way for all men and women to grow more fully can one nation expect to win the co-operation of other nations that are free. With acceptance of this objective as the alternative to national aggrandizement, both the safety and the well-being of a nation's citizens will be as firmly assured as is possible under present world conditions.

Powerful support of such a policy can be counted on. Thus a nation's leaders must recognize that only as its citizens grow in health and understanding and have their heart in its objectives can the nation's strength be fully realized. Such growth is, however, at its best only through co-operation on an international as well as a national level.

Every organization to which men look for inspiration is concerned that each person shall have open to him a life of meaning. Whether one's first loyalty is to his eternal God, or to the principle of right-dealing with his fellows, or to his system of government, the highest expression of that loyalty lies in promoting the health and human growth of men and women. Commitment to such a great human goal is precisely what is needed to give incentive to a person's best effort and meaning to his life.

To an increasing degree, society is giving its rewards to those who are opening new opportunities which all can enjoy. The Atoms for Peace Award is an example of this trend in public acclaim. Economic pressures and public opinion are encouraging every effort that would provide men and women with wider opportunities for growth as human beings.

In the autumn of 1945, Niels Bohr made an appointment to talk with me as we were journeying together toward Washington. Six months before, at Los Alamos, we had spent hours discussing how use of the atomic bomb, newly developed but not yet tried, might be turned toward establishing a harmonious and enduring peace. Following these discussions, one great question was now on his mind. "Is it not possible," he asked, "for the United States to perform some great moral act that will give hope to the world?" I suggested an action similar to what became the Marshall Plan, of economic help to the nations where help was needed. "Good," was his

answer, "but this is not the basic thing we need." In our discussion we failed to pinpoint what great moral act by our nation could accomplish what Bohr had in mind. Perhaps the time was not yet ripe.

The experiences of the past decade have opened our eyes. The American dream has grown to be the dream of the world. This dream must now become the world's united, all-compelling purpose.

The era of nuclear power began fifteen years ago as a result of unprecedented international co-operation. Those whose efforts were responsible for the birth of the era, and especially the scientists, were inspired by the hope that this new-found power would bring fuller life to all mankind. The Atoms for Peace Award is a symbol that our nation shares and cherishes this hope. Niels Bohr has called on America to lead the world in another great co-operative venture. This venture is that of committing the united efforts of the nations to the human growth of man. If in earnest we undertake to direct our own nation's prime efforts to this end, if we can bring the world thus to use to the full the powers of science and technology, the bright hopes inspired by nuclear energy will bear their full fruit.

Let us, the United States of America, proclaim boldly that what in our hearts has long been a precious dream is henceforth the corner-stone of our national policy. Let us call on all nations to share this policy with us, that the world may work as one toward giving every man and every woman the opportunity to grow to his full human stature. Let us put our policy into practice by assuring all nations who will share this commitment that we will counsel with them regarding our proposed actions of international concern, and will co-operate with them in providing their people and ours with means for healthy growth.

With such leadership in our present anxious world we can count confidently on a strong following. We may hope that our first steps will bring co-operation on an ever broader basis. It is a reasonable expectation that antagonisms will thus gradually be displaced by mutual confidence, and that peace based on harmony will grow.

No, competition and rivalry will not decline, but it will be with a new spirit. As the dream of the world is transformed into one united purpose, men and nations will seek to outdo each other in advancing the human worth of man. Because life then takes on meaning, our civilization itself will stir with new strength.

With such powers as nuclear energy in our hands, the need for affirming this united purpose is immediate and is vital to mankind. Failure by the United States to make this commitment and to call on all nations to do likewise will leave the world in jeopardy. Acceptance of this leadership will give new hope. It will put new life into the world. If we are unwilling to take the lead, to whom shall we look ?

UNIVERSITY OF BERGEN

NEW LABORATORY BUILDINGS OF THE BIOLOGICAL STATION

By Prof. HANS BRATTSTRÖM
Director

ON September 10, 1957, the new laboratory building of the Biological Station, Espegrend, was officially taken over by the University of Bergen (Fig. 1).

The Biological Station at Espegrend has had two predecessors. The first Station, inaugurated on September 10, 1892, was situated in Bergen. In the beginning it was mainly devoted to fisheries investigations, but after the Fisheries Directorate had been established in 1900, fundamental research in the marine sciences became the main task of the Station. Besides, it played an important part in the international courses in marine research which were arranged by the Bergens Museum. In 1917, the new Geophysical Institute took over the physical oceanographical programme of the Station, and in 1921 the biochemical investigations were transferred to a new Biochemical Institute. From then on the Station became a purely biological station, mainly devoted to fundamental marine biological research and education.

For various reasons the Station had to be closed down in 1921 ; but in 1922 a new and better Station was opened on the island of Herdla, north-west of Bergen. After almost twenty years of intense activity Station number two also had to be abandoned a short while after Norway entered the Second World War. For ten years the Station was on the move, until in 1949–50 staff and equipment were transferred to Espegrend, where the Bergens Museum (now the University of Bergen) had acquired new premises. Here the Station has worked under provisional conditions until the new laboratory building was ready in September this year.

The new Station is situated in one of the most charming parts of western Norway. It lies at the eastern shore of the Raunefjord, 20 km. south-southwest of Bergen, and it has road connexion with this town. The location is well suited for all kinds of marine research. Many different types of biotopes can be reached within a short time, from the extremely exposed rocky shores of the North Sea with high salinity, to sheltered fjords, bays and pools with more or less brackish water. Of special interest are the great deeps of the fjords, the current-swept shallow sounds with rich epifaunal communities, the *Lophelia* reefs and areas with shell sand (*Amphioxus*-bottom). Depths of 200–300 m. are found off the Station and depths of 700 m. can be reached in one hour. Also for intertidal studies the conditions are very advantageous. Several small ponds and lakes are found in the vicinity of the Station, and the landscape is very varying, providing good opportunities for terrestrial and limnological studies.

Fig. 1. The Biological Station, Espegrend

The Station has a new 63-ft. research vessel, *Fridtjof Nansen* (Fig. 2), well equipped for research down to the greatest depths in the Norwegian fjords (about 1,200 m.). The old R.V. *Herman Friele* is at present lent to the Biological Station at Trondheim. The Station also has a 30-ft. motor-boat, several rowing boats and an outboard motor. All types of gear for collecting bottom animals, fish, plankton and water samples are at hand, and also equipment for terrestrial ecological investigations.

The combined laboratory and boarding-house building is four stories high with a ground area of 575 sq. m. The fitting up of the building is being carried out in two stages. The basement, the ground floor and the first floor, containing laboratories and other service rooms, represent stage 1. This stage is complete. It is hoped that stage 2, comprising the two upper floors with accommodation for visitors, will follow shortly. In the meantime, visitors will be accommodated in other rooms and in other buildings belonging to the Station.

In addition to rooms for the scientific and technical staff the laboratory at present has available twelve rooms for visiting research workers, one bigger room for physiological and chemical investigations, and one for botanical work. The botanical laboratory has a study herbarium of marine algæ.

The Station has a small library of handbooks, marine biological journals and reprints. It exchanges publications with about two hundred other stations and institutes. Books not kept in the library can be borrowed from the University Library in Bergen.

Of other service rooms the basement contains a room for sorting material, three controlled environment rooms, storage rooms and a big aquarium hall. In the laboratory stories are two rooms for aquaria, a room for microtome work, a photographic dark room, a balance room and a room for storage of chemicals. An area of about 150 sq. m. is reserved for future work.

For educational purposes there is a teaching laboratory for 12–20 students. In this laboratory a study collection of marine animals is available. The room can be divided by curtains into five research laboratories. As additional tables are also in several of the above-mentioned rooms, the Station can accommodate about twenty research workers and 12–20 students (or twenty-five research workers). However, accommodation facilities are at present limited, and until stage 2 has been completed, the laboratory capacity cannot be used to the full.

From the Norwegian Research Council for Science and the Humanities the Station has received a sum

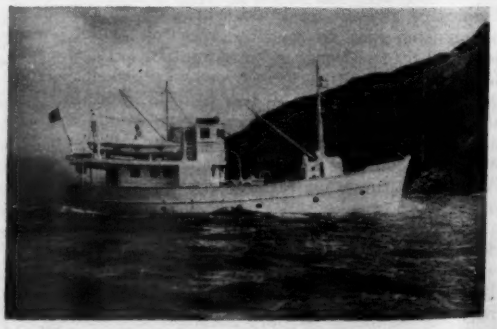

Fig. 2. R.V. *Fridtjof Nansen*

of £15,000 for equipment. Within a short time it will therefore be well equipped with standard instruments, glassware, etc., for botanical, zoological, physiological, biochemical and hydrographical investigations and for educational purposes, whereas visitors must be prepared to bring special instruments and microscopes as well as special or rare chemicals and personal laboratory equipment.

All laboratories have running cold and hot fresh-water as well as circulating sea-water. Gas, compressed air, etc., are provided by small transportable units. 220-V. alternating current is available. When furnishing the laboratories stress has been laid on great elasticity, permitting a rapid change from one type of laboratory to another.

The scientific staff is small. The Station is mainly a visitors' research laboratory, open all the year round for research workers from all countries. The visitors will get a laboratory or a table, material, instruments, chemicals and all the service that the Station can afford, all free of charge on condition that they publish their results in one of the publications of the University, unless dispensation has been given. The material collected belongs to the Station, and all types and duplicates of rare species have to be handed over to the Station after description. Furthermore, visitors must be prepared to pay for particularly expensive collecting trips and costly chemicals. Board and lodging will be available at a low price.

Application for a table should be sent to the director, if possible one month in advance (for the months June–August not later than May 1). Exceptionally the Station can send material for investigation in other laboratories on the same conditions as those mentioned above.

The Station will give courses in botany, zoology and marine biology for students from the Universities in Bergen and Oslo, and also for students from the other Scandinavian countries. The last-named courses are part of a joint Scandinavian programme for education and research recently started. The Scandinavian countries also exchange scholarship holders.

BIOLOGY OF YEAST

DURING the British Association meeting at Dublin, Sections B (Chemistry) and K (Botany) held a joint session on September 9, at which "The Biology of Yeast" was discussed. Prof. D. G. Catcheside read the first paper, which was on "The Genetics of Yeast". He said that although regular transmission of genetic traits to daughter cells shows that an orderly process of chromosome division exists in yeasts, the details of the mitotic process, and even the identification of nuclei and other cellular organelles, have not yet been satisfactorily settled. Yeast has a simple lifecycle with an alternation of haploid (sexual) and diploid (asexual) generations. The haploid cells belong to one or other of two opposite mating types, determined by Mendelizing genes, and possessing some of the attributes of different sexes. When haploid cells of opposite mating type are mixed, they become associated in pairs and fuse to form zygotes, within which the two haploid nuclei fuse. Under conditions favouring growth the zygotes germinate to produce the diploid phase which can later be caused to sporulate by starvation. The mating types segregate characteristically in sporulation. The main difference between this process and the genetical cycle common to most higher plants and animals is that the segregation products of any one event of meiosis are kept as a group of four ascospores in the yeast ascus, and if these ascospores are isolated they reproduce vegetatively. This results in a substantial gain in genetical information, so that genetical analysis may be applied to discovering details in the life-history of yeast which have so far eluded the cytologist who studies these problems with a microscope.

Complexities may be introduced into inheritance patterns because, first, the mating types are able to mutate, though rarely, from one to the other, and, secondly, the haploids can undergo chromosome doubling by an unexplained process to produce diploids of either mating type. When the latter take part in sexual reproduction, triploids or tetraploids are formed, and these show complicated genetic segregations at sporulation, and this has in the past led to difficulty in interpretation of results. When sporulation occurs in triploids or tetraploids, mating type segregates in a trisomic or tetrasomic manner, and in either case the frequency of each type of ascus depends upon the position of the gene in the chromosome with respect to the centromere. The extreme cases are when crossing-over between the locus and the centromere of its chromosome is either zero or limiting; any particular case is likely to be intermediate between these two limits. This obviously leads to situations which cannot be recognized and distinguished without careful genetic analysis, lack of which has led to confusion in yeast genetics.

The number of chromosomes in yeast can be determined by two distinct genetical methods. The first method depends on the determination of how many linkage groups there are, while the second depends on the formation and analysis of an aneuploid zygote which is trisomic for one chromosome and disomic for the rest, so that, on sporulation, characteristic trisomic and disomic ratios may be obtained for genes located on the respective chromosomes; a disomic ratio for one factor occurring with a trisomic ratio for a second factor shows that the two factors must be in different chromosomes. At least eight linkage groups have been recognized so far by these methods, putting a lower limit of eight to the chromosome number. The recent discovery and use of linear asci should give valuable information on reduction division and the frequency with which reduction occurs at the first and second division of meiosis. By a detailed discussion of one group of inherited characters (adenine dependence, red colour) some of the techniques and results of genetic analysis were illustrated.

Prof. E. J. Conway then read a paper on "Cell Structure and Function in Yeast". Having outlined the principal structural features of the yeast cell, he

pointed out that the cell membrane and its functions had been subjected to intensive investigation, and that this was not surprising as one of the most interesting features of the internal environment of this organism is its very high osmotic pressure. It is clear that there must be some mechanism which allows ions to reach the interior of the cell but prevents them from coming out again, and at least three explanations of this mechanism have been suggested: passage through pores in the membrane; solution in a lipid layer of the cell membrane; and active transport which involves temporary combination with a chemical entity at one side of the membrane and with consequent liberation at the other side. The 'cylindrical pore' theory has been investigated by finding the selective permeability of the membrane in terms of the relative sizes of the ions, due regard being had to the facts that hydration may alter the relative sizes of ions and that electrical forces depending on membrane potential difference and ion valency may affect rate of penetration of ions. It is generally true that larger ions pass through membranes only with difficulty, but no quantitative relations have been established. Danielli's theory of a double lipid layer with protein monolayers has been investigated by comparing rates of penetration of substances with their lipid solubility, and, although there is a general proportionality, no exact relation holds.

The active transport theory was then discussed by Prof. Conway with reference to studies made in his laboratory on the mechanism of acid production by yeast, on the nature of the acid produced, on the effect of acid production on the environment of the cell, and on the transport of cations across the yeast cell wall. During the fermentation of unbuffered glucose solution, yeast produces acid by two processes: liberation of succinic acid (in the absence of salts) and exchange of hydrogen ions formed internally for potassium ions (when potassium is present in the medium). The latter process, which is accompanied by a quantitative increase in bicarbonate ions in the cell, results in an accumulation of potassium ions in the yeast and an outside *p*H falling as low as 1·4. The experimental results are best explained on the basis of a redox system—the so-called redox pump mechanism. This hypothesis requires the existence of a mobile redox system within the cell membrane which, having been reduced, say by metabolic hydrogen, would complex with a cation at the internal boundary of the membrane; this complex would then orient itself to the external boundary, where on transferring its electrons to an acceptor system it would release the cation to the medium. It is possible to replace the internal potassium of the yeast cell by sodium or ammonium and so make the interesting 'sodium yeasts' and 'ammonium yeasts'; these interchanges are readily reversed. Although we have gained some insight into how the cell membrane functions, a description of the complete pattern of organization within the yeast cell must await further knowledge of the functioning of its subcellular components.

The third paper, on "The Biochemistry of Alcoholic Fermentation", was read by Dr. R. Davies. He referred to the fact that it was just one hundred years since Louis Pasteur published his first paper on alcoholic fermentation, in which fermentation was defined as life without air. Since then it has been found that fermentation depends on a series of internal oxidations and reductions in which energy is released in a form in which the organism can use it for synthesis of cell material. The energy is stored principally in high-energy phosphates of which a typical member is adenosine triphosphate. Because of the high energy of the terminal phosphate bond, this can act as a link between the energy-liberating metabolic reactions and the energy-requiring synthetic reactions. The fermentation of sugar by yeasts involves four phases: first the passage of the sugar across the outer cell membrane into the cell; second, the preparation of the sugar for entry into the energy-yielding mechanism proper; third, degradation to ethanol and carbon dioxide; and fourth, synthesis of cell materials. Two molecules of adenosine triphosphate are used up in phase two (this is the energy required to set the process going); four are released in phase three, so that there is an overall gain of two molecules of adenosine triphosphate per molecule of glucose fermented; these high-energy phosphates are then available for synthetic work in phase four. The series of reactions in phases two and three, which are known as the Embden–Myerhof–Parnas glycolysis system, involve the chain glucose, glucose-6-phosphate, fructose-6-phosphate, fructose-1 : 6-diphosphate, phosphoglyceraldehyde (and dihydroxyacetone phosphate), 1 : 3-diphosphoglyceric acid, 3-phosphoglyceric acid, 2-phosphoglyceric acid, 2-phosphoenolpyruvic acid, pyruvic acid, acetaldehyde (and carbon dioxide), and finally ethyl alcohol. The interconversion of each pair of these intermediates requires its own enzyme and frequently a coenzyme. The action of these enzymes accounts for alcoholic fermentation of glucose or fructose, but for the fermentation of galactose at least three further enzymes are required, and these enzymes may correspond with three dominant genes shown by genetical investigations to be involved in galactose fermentation. In the passage of sugar into the cell (phase one) it has been found that the cell membranes exhibit highly specific permeabilities and that some ions pass into the cell only by active transport, which takes place while the cell is metabolizing. The uptake of amino-acids, and of certain β-galactosides, by *Escherichia coli* involves active transport but also appears to be mediated by substances having all the properties of enzymes which have been called permeases. For yeast, only the uptake of α-methylglucoside has so far been shown to involve permease action. It may be that the formation of permeases is genetically controlled and it is possible that if rate of fermentation of a sugar is limited by permease activity, this may provide an explanation of cases in which an oligosaccharide ferments at a higher rate than its component hexoses.

The fourth paper, on "Yeast Biology in Relation to Fermentation Techniques", was read by Mr. R. B. Gilliland. He first mentioned the many industries interested either in yeast production or in the products of fermentation, and went on to say that studies of the genetics, biochemistry, cytology and physiology of yeast have contributed to the improvement of industrial techniques and the solution of industrial problems. As examples of this, the improvement of yeast strains, the production of strains with new properties, the control of the balance between flocculated and dispersed yeast, and the control of the balance between aerobic respiration and anaerobic fermentation, were discussed. Con-

siderable improvements in the performance of yeasts have been made by strain selection and, more recently, by the production of new hybrid strains. Yeast appears to have an advantage over other organisms in that its haploid generation can have a free existence, and may be tested, so that a selection of the best haploids may be used for hybrid production. This apparent advantage is largely illusory, as any character except the very simplest may be governed by many genes, so that the ability of a diploid cannot be judged by the separate abilities of its haploid components. The best method of finding better strains may therefore be to screen large numbers of randomly produced hybrids. Several producers of baking yeast have already found artificially produced yeast hybrids which are superior to naturally occurring strains, but apparently no other industry has yet used yeast hybrids commercially. Nor have polyploid yeasts been used commercially, though they have attractive qualities in that they are larger, ferment faster, and give higher yields than diploid yeasts.

The fermentation of various sugars, such as maltose, sucrose, raffinose and galactose, is under simple genetical control in yeasts, and this has recently been found to extend to the fermentation of maltotriose, dextrin and starch. Practically any selection of carbohydrate-fermenting abilities could be combined in one yeast, with possible applications both in industry and also for isolation of the individual enzymes.

It is very disconcerting if an industrial yeast changes its properties; fortunately this is very rare, but brewing yeast does occasionally change its flocculation characteristics. The ability to flocculate is controlled by from one to three pairs of dominant genes which are more than ordinarily subject to mutation. Flocculation generally requires calcium ions, sometimes alcohol, is inhibited by mannose, maltose or glucose, but not by mannitol, raffinose or fructose, is dependent on *p*H and on surface tension, and sometimes is achieved only when another mutually flocculent yeast is present. All this is known, but there is much that is not known about the phenomenon and we have not yet got complete control of the balance between too intense and too weak flocculation, either of which may cause technical difficulties. A recent innovation is the deliberate use of two yeast cultures, one flocculent and one dispersed, in a brewery, with control by adjustment of the percentage of each in the mixture used for brewing.

The balance between respiration and fermentation is of importance both to producers of yeast and to industries dependent on the products of fermentation. For the former, intense exponential aeration and exponential feeding give the maximum production of yeast for the amount of carbohydrate used, with no alcohol in the residue. For the latter, aeration is necessary to keep the yeast healthy and vigorous, but too much aeration would lead to loss of alcohol production, so that just the correct amount of aeration is essential.

In a short but lively discussion the comparative values of protein extract from grass and of food yeast were questioned. The flavour of the former was stated to be sickly and unpleasant and the texture of the latter did not compare favourably with roast beef, so that in communities which enjoyed a good mixed diet neither was likely to appeal; but where dietary protein was low either might form a valuable additive, if not a main course. The function of glycogen in the yeast cell was admitted to be still a mystery, while the aerobic fermentation of glucose by osmophilic yeasts was probably due to a shunt from the main system into one of the many alternative pathways.

R. B. GILLILAND

UNIVERSITY APARTHEID IN SOUTH AFRICA

THE proposals of the South African Government to enforce racial segregation at the university-level and to exercise rigid control over projected colleges for non-whites has caused concern and indignation in university circles throughout the Commonwealth and beyond. Some of this concern found expression in a well-attended meeting held at the Caxton Hall in London on November 2 under the sponsorship of the International Committee on Science and Freedom in co-operation with the Association of University Teachers. Dr. J. W. Cook, vice-chancellor of the University of Exeter, presided at the meeting, which by an overwhelming majority passed a resolution expressing admiration and support for those South African universities which are resisting their Government's policy and calling upon the South African Government to heed the cruel and disastrous consequences of its policy and to abstain from its further pursuit. Messages of support for the protest against university apartheid had been received from a number of organizations, including the Senatus of the University of Aberdeen, University of British Columbia, University of the Philippines, University of the Punjab, University of Delhi, the University College of North Staffordshire, various branches of the Association of University Teachers and the National Union of South African Students.

In his introductory address, Prof. M. Polanyi, chairman of the Committee on Science and Freedom, outlined the Committee's activities during the past three years. He described the apartheid issue as one in a chain of campaigns "always the same in different form". As in other cases, the claim was made that this issue had nothing to do with academic freedom; but if it had, then academic freedom must yield to higher considerations of social interest. Prof. Polanyi suggested that it is an obligation on universities to teach young people those ideas which it is the duty of society to maintain; that any violation of these ideas within the universities cannot be tolerated; and that to demand the participation of universities in a programme of inhumanity, oppression and intellectual dishonesty is a violation of academic freedom. The general philosophy of apartheid, against the

background of the racial composition of South Africa, was discussed by Rev. Michael Scott, honorary director of the Africa Bureau and spokesman for the African tribes in the United Nations. Apartheid, he said, has two faces: with one it looks out on the world at large, and with the other it confronts its own non-European people. To the outside world it is represented as a solution to the problem of race relationships, whereby each race is thought of as developing separately and along its own traditional lines, and within its own separate socio-economic system. To the peoples of South Africa, apartheid means White supremacy, which in practice means Afrikaaner domination over all other peoples for the foreseeable future. During the ten years in which the Nationalist Government has been in power, the repressive aspect of apartheid has found expression in legislation for tightening of control over both physical and political movements. As several later speakers recognized, university apartheid is a natural and general development of this repressive policy.

The two main principles of this policy which emerge from the Separate University Education Bill were referred to by the next three speakers, Prof. Kenneth Kirkwood, Dr. J. W. Cook and Lord Chorley. The first new principle is the proposed creation of a system of university colleges for non-whites (that is, Asians, Africans and coloured people of mixed origin). The colleges are to be established on a tribal basis, and the most notable feature is the very strict measure of control which the Government intends to exercise. Moreover, whereas in previous university legislation in South Africa it has been possible to dismiss the matter of misconduct by university staff in a couple of lines, in the proposed new law some 300 lines are devoted to this question. By a provision which, as Lord Chorley said, must be unique in the history of any civilized community, the staff are made retrospectively liable for misconduct committed before the date of transfer to the new regime. The position of teachers in the new institutions would be one of legal rightlessness which has scarcely been known in any free community since the serfdom of the Middle Ages. The second main principle of the Bill is the ministerial determination of the composition of the student bodies of the existing universities and the exclusion of non-white students in the future. These two principles are indeed supported by the majority of the academic staff of the four universities using the Afrikaans medium, but Prof. Kirkwood stressed that it is a majority and that there is no complete unanimity even in these universities. In the other four South African universities opinion is, of course, overwhelmingly against the Bill. This Bill, which received its second reading on May 27, was on the following day referred to a Select Committee.

Prof. Kirkwood, while acknowledging that there is the apartheid tradition in the Union, pointed out that there is an equally valid non-racial tradition which found its expression chiefly during the long years of British Colonial administration in South Africa, in the Cape Colony, in the Colony of Natal and elsewhere. The practice of non-racialism has been by no means confined to the English-speaking group, and it is a practice which in the universities originated more than half a century ago. Contrary to what has sometimes been suggested, it is not at the mixed universities that friction has arisen; it is in the segregated institutions that there is a sense of grievance at the denial of opportunities and facilities that are available elsewhere. Dr. Cook recalled some of the principles of self-government of the universities of the United Kingdom which are violated by the provisions of the South African University Bill, and contrasted the proposals to enforce racial segregation with the conditions which obtain at the newer university colleges in some of the British overseas territories. Of particular significance is the multi-racial character of the University College of Rhodesia and Nyasaland. The Federation adjoins the Union and has a somewhat similar racial distribution with similar social conventions.

Perhaps partly because of the ties of common ancestry with the Afrikaans-speaking population of South Africa, the Netherlands Association of University Professors and Lecturers was not officially represented, and Prof. W. T. Koiter, of Delft, emphasized that he was present in a personal capacity. But he left no doubt about the general feeling in the Netherlands universities in favour of academic freedom; and he concluded a forceful speech against the policy of apartheid with a plea to those in the South African universities who have so far supported their Government to join forces with their colleagues in the 'open' universities, and not to indulge in the illusion that academic freedom can be retained when all students are segregated according to their race.

The audience gave a polite but sceptical hearing to Prof. L. J. du Plessis, of the Potchefstroom University, who had come over from South Africa to present the case in favour of university apartheid. The principle of the scheme for compulsory separate university education, he said, has already been accepted by the Union Parliament. The matter still open for discussion in the light of the evidence to be submitted to the Commission would seem to be mainly the intensity of the Ministerial control over the non-European university colleges and the stages to be observed in the exclusion of non-European students from the existing residential universities. The new university institutions are to complete the educational structure already developed for the non-white groups from the elementary school stage upwards. They are meant to supply intellectual leaders for the several racial groups, and such leaders can only be satisfactorily educated in racially homogeneous institutions. Provision will be made in the near future to transfer control of Fort Hare University College and the Durban Medical School to the Government. The present situation does not give the same scope for development of non-whites as would be given in separate institutions. Prof. du Plessis conceded that the measures proposed would constitute some limitation of university autonomy, but this the State was entitled to do on behalf of over-riding national interests. In any event, control of the new institutions by Government departments is rendered necessary by the fact that the Government initially supplies all the funds, and that a responsible authority is needed to prevent undesirable ideological and other developments. Quality will be guaranteed by the University of South Africa, he said, so there is no validity in the argument that the standard of the separate institutions will be inferior. The principle of racially segregated university institutions will open the way for the employment of non-whites on an ever-widening scale in the highest university positions.

In his brief reply to the ensuing general discussion, Prof. du Plessis said: "If I were in England, I would be an integrationist too, because it is not a danger to English national character, and if I were in America I would be an integrationist too; the negroes in America are in no danger of destroying that great nation of America in its identity. But the Bantus and Indians and Coloureds of South Africa, if they are integrated more fully than they are now, would undoubtedly destroy our great South African nation".

The general discussion, in which Prof. J. L. Montrose, Prof. A. J. Ayer, Mr. L. Behrens and others took part, was largely concerned with what steps could be taken to assist the South African universities and the non-European students. Mr. T. D. Smith outlined what was being done in Oxford by the Joint Action Committee against Racial Intolerance, now a university society with more than two thousand undergraduate members, which is raising a fund to provide a scholarship for a non-white from South Africa. Dr. H. J. Grenville-Wells, who was brought up in South Africa and attended for five years a South African university, deplored the fact that she had had to come to England and go to America to meet Africans of university standard, and to find out what Africans and other coloured people want for themselves. At a meeting where plain speaking was not spared, this seemed to some the most telling indictment of apartheid.

THE CHEMICAL SOCIETY OF FRANCE, 1857–1957

THE centenary of the Société Chimique de France was celebrated in the Sorbonne on July 16, the President of the Republic, the Minister of Education, and the Secretaries of State for Agriculture and Public Health being present. An address was given by the president of the Society, Prof. R. Delaby, who reviewed the history of the foundation and development of the senior association of French chemists. It was founded on June 4, 1857, on the initiative of three young chemists, Arnaudon, Collinet and Ubaldini, who, with a few other young colleagues, decided to meet weekly for the purpose of keeping in touch with all branches of the science by reading memoirs, extracts, and abstracts of work published in French and foreign journals. At that time the younger chemists of France included Wurtz, Sainte-Claire Deville, Pasteur and Berthelot. Dumas was president in 1859, Wurtz being secretary and Pasteur and Cahours vice-presidents. In 1864, the publications of the Society were united under the title of *Bulletin de la Société chimique de Paris*; in the same year a decree of Napoleon recognized the Society as of public utility. By the creation of the *Bulletin* the Society acquired a growing influence, the enthusiasm of Wurtz being especially influential, so that he was regarded as the true founder of the Society.

When the Society was founded, the chemists of France were divided into three rival schools. That of Sainte-Claire Deville at the École Normale Supérieure continued the older traditions of Berthollet and Gay-Lussac, who were mainly interested in physical chemistry, and it continued to use the dualistic notation of Berzelius. In the École de Pharmacie, Berthelot used the equivalent formulæ (as he did for long after Cannizzaro's atomic weights were accepted by other chemists). In the École de Médecine, Wurtz was a protagonist of the new school, based on the atomic theory, and with his collaborators, including Friedel, Ladenburg, Salet, Crafts, Grimaux, and Beilstein, used structural formulæ and the idea of chemical bonds. On account of Wurtz's influence, the new Society became the centre of interest in atomistic ideas in France. Delaby quotes what was said by Gautier on the occasion when the Society had reached its fiftieth year, to the effect that in passing from one school to another in the earlier times, a young chemist had to learn to speak a different chemical language as well as to make profound adjustments in his outlook on chemical theory.

In 1884, it was proposed that the name of the Society should be changed to Société Chimique de France, but authorization for this was not given by the Council of State until 1906, the statutes being amended accordingly. Among past presidents were three permanent secretaries of the Académie des Sciences, Dumas, Pasteur, and Berthelot, and three recipients of a Nobel Prize, Moissan, Grignard, and Sabatier. Delaby in his lecture gave brief accounts of the careers of several presidents of the Society. Dumas is best known for his discovery of substitution and homology; he was the author of a large "Traité de Chimie appliquées aux arts" and the famous "Leçons de philosophie chimique". Pasteur, a great experimenter, founded stereochemistry, and later in his researches in the fields of biochemistry and biology made important contributions to medicine. Berthelot contributed to the fields of organic synthesis, thermochemistry, the physical chemistry of the detonation wave, and the chemistry of agriculture, as well as to the history of Greek alchemy and the alchemy of the Middle Ages by the publication of texts. He also occupied important positions in the State—senator, Minister of Public Instruction, and Foreign Secretary. Moissan worked mainly in the field of inorganic chemistry; he discovered fluorine and invented the electric furnace, with which he studied the carbides, borides and silicides of metals. Grignard is well known as the discoverer of the organomagnesium compounds and of their applications in organic synthesis. Sabatier was a pupil of Berthelot and was associated with him in many researches, but is best remembered for his process of catalytic hydrogenation, partly worked out with Senderens. Later notable names are Moureu, Urbain, Delepine, Matignon, and Jolibois, whose work was briefly reviewed.

Prof. Delaby's lecture gave an interesting survey of the development of chemistry in France from about 1850 to the present day. It shows how the Société Chimique de France participated in this and how the most famous members of the Society advanced the various branches of the science. It is a record of which the French nation is justifiably proud.

J. R. PARTINGTON

OBITUARIES

Prof. C.-G. Rossby

Prof. Carl-Gustav Rossby, director of the Institute of Meteorology, University of Stockholm, died suddenly on August 19, at the age of fifty-nine. With his untimely death, meteorology has lost its most colourful, stimulating and provocative exponent of the past twenty years or so. Rossby was a native of Stockholm and graduated from its University in 1918. Geophysical science was 'quite the rage' in Scandinavia in those days and Rossby was immediately attracted to its 'Mecca', the Geophysical Institute at Bergen, where for the next two years he worked under Prof. V. Bjerknes, and with the several exponents of the famous air-mass and frontal school of meteorology. He continued his geophysical studies for a year at Leipzig, where V. Bjerknes had formerly occupied a chair, and then entered in 1932 the Swedish Meteorological and Hydrographic Service. In 1926, he was awarded a fellowship, by the Swedish-American Foundation, to propagate the gospel of the Bergen school among meteorologists in the United States, and this led, a year later, to his appointment under the Guggenheim Fund for Promotion of Aeronautics to apply meteorological knowledge more effectively to aviation. The role was exacting and, apparently, often exciting; but it failed to satisfy the scholar that lay somewhat hidden behind the many other qualities that made up Rossby.

In 1928, the Massachusetts Institute of Technology invited Rossby to become its first head of a department of meteorology. When he left it, in 1939, academic meteorology was well founded in the United States. For the next two years Rossby was assistant chief of research to the U.S. Weather Bureau, but on America's entry into the War he was appointed to a new chair of meteorology at the University of Chicago and directed a large effort on the rapid training of meteorologists to satisfy the needs of the Armed Services. He retained his chair at Chicago, where he became distinguished service professor, until 1950, but from 1947 onwards he spent about half his time in the University of Stockholm where he created yet another department of meteorology, this time of an avowedly international flavour. Stockholm was indeed his home from about 1949, but he continued to make occasional extended visits to the United States, mainly for work at Woods Hole Oceanographic Institution.

Rossby's direct contributions to meteorology and oceanography were rather closely phased to his various academic appointments. During the period when he was at the Massachusetts Institute of Technology, Rossby was largely concerned with the theory of atmospheric and oceanic turbulence and with meteorological thermodynamics. He developed the latter as a tool in air-mass analysis and sought the workings of large-scale atmospheric processes in isentropic analysis, that is, by the charting of the contours of isentropic surfaces. Others failed to advance the subject significantly by its aid, and the technique lapsed. But it led Rossby on to his major work, the form and behaviour of atmospheric flow on the planetary scale. Earlier work in this field had been almost entirely climatological, but Rossby dealt with the instantaneous pattern, a circumpolar system of 'long' waves most in evidence in the westerlies of the middle and upper troposphere, and its evolution. Well enough aware that all atmospheric motion is essentially thermally driven, Rossby sought to find how far a purely inertial model of the atmosphere would take him in the description of the large-scale flow field. This was characteristic of Rossby: not to attempt to solve the problem of atmospheric motion in all its bewildering complexity but to see whether major features could be accounted for in relatively simple terms. By about the end of his period at the Massachusetts Institute of Technology he had on the basis of the conservation of absolute vorticity developed the famous Rossby equation

$$C = U - \beta\left(\frac{L}{2\pi}\right)^2$$

where C is the speed of propagation of long waves of length L in a zonal air current of speed U, and β is the variation of the Coriolis parameter with latitude. For large wind speeds or low wave-lengths the waves are propagated downstream at relatively high speed, whereas for low wind speeds or large wave-lengths the waves may retrogress.

The Chicago period was one of elaboration and application of these ideas. Upper-air data on pressure and wind fields were accumulating rapidly and the long-waves could be mapped with some thoroughness over a large part of the northern hemisphere on a day-to-day basis. The 'jet stream' was identified as the fast-moving core of air embedded in the upper long-waves and Rossby sought an explanation, not quite successful, in terms of conservation of vorticity and large-scale mixing.

I well remember a hot August day in Chicago in 1947 when I was privileged to attend the daily conference on the current large-scale synoptic situation at which the long-wave and jet ideas were under discussion and application. This was a period too when Rossby, with others, began to see the possibility of applying the hydrodynamical equations of his or other model atmospheres for numerical weather prediction, using the new high-speed, electronic computers. That research is still very active.

Dynamical problems were by no means dropped during the final Stockholm period, but Rossby was looking for new interests and found them in the study of atmospheric micro-chemistry. He organized a network of stations in Western Europe at which the concentration of various radicals, such as sulphate, chloride, etc., in the air and in precipitation, was measured on a routine basis to provide their distribution in space and time. Such information, Rossby believed, would lead to important advances in meteorology, oceanography and agricultural science. He leaves in Sweden workers who can be expected to continue this research from the point now reached.

An account of Rossby's interests and original work shows only a part of the great character he was. Probing, puckish, kindly, cultured, a great European and a great American, he was much honoured, both formally and by the many who could call him friend. A light has gone out and the world is in debt to Scandinavia for one of her great sons of geophysics.

P. A. Sheppard

Dr. Robert Chambers

Robert Chambers, perhaps the most distinguished figure in the field of experimental cytology, died recently at the age of seventy-five. Of Canadian parentage, he was born in Turkey, where his early years were spent in fascinating and, at times, exciting surroundings. As a young man he graduated at Queen's University, Ontario, and after a period spent in Richard Hertwig's laboratory at Munich, he held teaching and research posts at Cornell and elsewhere. In 1928, he was elected to a research professorship at New York University, Washington Square; this post he held until his retirement.

Chambers was largely responsible for the development of micro-dissection as a means of investigating the properties of living cells. He was a brilliant technician; to watch his control of a needle or pipette was an inspiration in itself, and much of our knowledge of the processes of fertilization and cleavage of an egg we owe either directly to him or to the enthusiasm which he inspired in others. Not the least of the lessons which he taught was modesty when an experiment went well, and absence of impatience or depression when things went wrong. He was the author of a very large number of papers, all characterized by their conciseness and clarity of style. Nearly—but perhaps not quite—all his conclusions have been substantiated by the use of techniques much more elaborate than his own.

During the inter-War years Chambers travelled extensively in Europe and made many friends. His handsome features, lit by a characteristically jovial smile, made him a welcome visitor to any laboratory; within a few days, he became "Robert" and remained so to young and old alike. For the best part of a generation he and his wife, Bertha, kept open house at their home in Woods Hole or New York. They had the supreme gift of welding a heterogeneous mixture of individuals into a happy gathering free from the strain of scientific research and the troubles of the outside world.

Superficially casual in the affairs of everyday life, Robert's scientific vision was remarkably acute and he pursued his ends tenaciously and unselfishly. He founded and was editor of a journal (*Protoplasma*), and he started centres of informal discussion which grew into well-organized and successful societies. He received many honours, but among these the affection of his friends and their respect for his scientific work must have ranked highly. Perhaps his most endearing and characteristic quality was his ability to remain young and—superficially at least—carefree. There can be few biologists of his own generation to whom his death did not bring a sense of personal loss, and younger cytologists will be among the first to acknowledge the lasting value of his scientific work.

J. Gray

Prof. Jean Giaja

Biologists everywhere will learn with regret of the sudden death in Belgrade on October 1 of Prof. Jean Giaja, otherwise Ivan Djaja, which occurred during a symposium on hypothermia, of which he was president. The symposium was being held in connexion with the fifteenth International Congress of Military Medicine and Pharmacy. Physiologists and medical men from many lands had gathered to honour Prof. Giaja and to discuss recent advances in the study of hypothermia, a subject in which he was an authority and had been a pioneer.

Giaja was born in Dubrovnik on August 21, 1884. His father was the skipper of a four-masted barque which sailed the oceans, so that young Giaja was often left with his mother, who was a Frenchwoman and who influenced him greatly and provided a rich cultural background. He graduated from the University of Belgrade and, after a year at Rouen, moved to Paris, where he spent six years doing physiological research under Prof. Dastré. He was awarded the degree of doctor of biological sciences at the Sorbonne. Then, in 1910, he was appointed professor of physiology in the University of Belgrade. There he remained until his death.

During the past fifty-two years Prof. Giaja had published many original articles and reviews. Between 1906 and 1920 he studied the enzymic breakdown of glucosides and carbohydrates in mammals, birds, fish, invertebrate marine animals and yeasts. This led to investigations of energy intake and expenditure by yeasts, and by poikilothermic, homœothermic and hibernating animals. His results enabled him to draw important conclusions about the regulation of heat production and maintenance of body temperature in birds and mammals. As long ago as 1930 Giaja began to study mammals with reduced body temperatures. He was the first to use the rat for this purpose and to show the protective action of hypothermia in a variety of adverse conditions including lack of oxygen. Twenty years passed before the subject of hypothermia became fashionable as a result of its application to cardiac surgery in 1950. By then a firm physiological basis for its use had been laid by Prof. Giaja.

Although nominally he retired three years ago, Prof. Giaja continued active research until the last. One of his recent articles on "Survival of the Heart following Deep Hypothermia" was recently published in *Nature* (178, 1286; 1956). He was a member of the Serbian and French Academies of Sciences, of several Yugoslavian and French scientific societies and of the Légion d'Honneur. Among his hobbies were gardening, boats, music, reading and travel.

Prof. Giaja had a charming personality and inspired admiration and affection in his students, his colleagues and his numerous friends among scientists overseas. He is survived by a daughter and by his second wife, who had worked with him for many years.

Audrey Smith

Prof. Antonino Mura

The untimely death of Antonino Mura, which occurred on July 24, near Milan, deprived physics of a dedicated student. He was born in Florence on March 19, 1916, and after attending the Scuola Normale Superiore in Pisa, obtained his doctor's degree in physics in 1938. Of the nineteen years since then, five were spent with the army during the War, and eight were clouded by the disease that eventually killed him. The remaining years were wholly dedicated to teaching and research at the University of Milan, where Mura contributed so much to re-establishing the academic and scientific activities of the Department of Physics after the Second World War.

Notwithstanding the odds against him, Mura continued to perform remarkable research work in the field of cosmic-ray physics. He started in 1945

studying the extensive (Auger) showers, and the properties of their penetrating component. Soon afterwards, he developed the cloud chambers which were to be successfully operated at the Alpine laboratory of Testa Grigia to investigate the characteristics of the nuclear disintegrations induced by cosmic rays: Mura and his co-workers determined the strong nuclear properties of the 'shower' particles emitted from the disintegrations. This research, and later work on the production of neutral pions and on the development of the nucleon cascade, shared with other investigations carried out in the same years in different countries the merit of bringing about the present understanding of the phenomenological aspects of the cosmic radiation: namely, that the extensive, the penetrating and the mixed showers are but different offspring of the high-energy nucleon–nucleon collision, the most catastrophic phenomenon of Nature.

It was with the intention of collecting information relevant to the behaviour of high-energy particles that he and his colleagues engaged in the study of phenomena underground. They demonstrated the groundlessness of reports from other investigators suggesting that the muons might give rise to previously unknown sub-atomic particles: the assumption of non-electromagnetic interaction properties of the muons could thus be discarded.

After this work, Mura was no longer able to participate directly in the experimental activity: in his last years his ailing body prevented him from contributing more than advice, criticism and interpretation of results. His interest in physics remained, however, unabated; and to the very end of his life he continued to discuss scientific subjects either in letters or with gatherings of his collaborators around his hospital bed.

The association of most of Mura's work with such an exacting and delicate instrument as the cloud chamber was not casual. He was at heart a respectful student of Nature, and elected to depend on a research tool presenting a straightforward kind of evidence of Nature's ways. His particular excellence as a physicist lay in his relentlessly critical mind, striving to uncover whatever truth, if any, might be hidden under uncritically accepted, misleading or exaggerated statements.

This earnest approach to the object of scientific research did not prevent him from being good-humoured and witty; and this indeed was his prevailing mood in performing his duties and in his contacts with people. He made an ideal partner in team-work, because he sincerely believed that everyone tries always to do his best. He never complained of his fate, of which he must have been deeply aware.

Giorgio Salvini

NEWS and VIEWS

Artificial Meteors

It is reported from the United States that in an experiment devised by the U.S. Air Force Research Station at Cambridge, Massachusetts, artificial meteors in the form of aluminium pellets were released by an Aerobee rocket at an altitude of 54 miles over New Mexico on October 16. It is probable that some of the meteors, which were ejected from the rocket by means of shaped charges of explosive, may have achieved speeds in excess of the velocity of escape from the Earth's gravitational field. A photograph taken with a Baker Super-Schmidt meteor camera is said to have shown one of these meteors travelling at a speed greater than 33,000 miles per hour, with a brightness of stellar magnitude −2. Observations of the temperature (luminosity) and rate of vaporization of artificial meteors, the composition and mass of which are known, are likely to be of use for determining the density of the Earth's atmosphere at great heights. Radar observations of the ionized trail of such meteors may also be expected to throw light on processes occurring in the ionosphere.

Electrical Engineering at The Queen's University, Belfast: Prof. P. L. Burns

Prof. P. L. Burns, who retires from the chair of electrical engineering in The Queen's University of Belfast at the close of the present session, received his engineering education at the University of Manchester, where, during the First World War, he was associated with Lord Rutherford in the problem of the detection of submarines. His practical training was obtained in the then British Westinghouse Co. at Trafford Park, Manchester. He entered the teaching profession in 1918, being successively in charge of the electrical engineering departments at Hull Technical College and at Rutherford College, Newcastle upon Tyne, before being appointed in 1924 to the position of head of the Department of Electrical Engineering and Physics of the Belfast College of Technology and extra-mural professor of electrical engineering in The Queen's University of Belfast. This position he held until 1955 when, with the formation of the Joint Authority for Higher Technological Studies, he became the first holder of the university chair in his subject, being still associated with the Belfast College of Technology as director of higher studies in electrical engineering.

Prof. Burns's tenure of the chair has been marked by steady developments in both the University and the Technical College sides of the department, in all of which his skill as a teacher found full scope. His interest in the students has not, however, been confined to their academic studies, for he has interested himself in all their activities. For a considerable period during and after the War he commanded the Signals Unit of the Senior Training Corps, for the formation of which he had been responsible. He was elected president of the University Rugby Club, and his cheerful and enthusiastic figure is a familiar sight on the touch-line at all university matches. Prof. Burns carries into his retirement the best wishes of his colleagues and of the long line of students who came under his influence, many of whom now hold positions of high responsibility in industry.

Dr. J. C. West

Dr. J. C. West, who has been appointed to succeed Prof. P. L. Burns, entered the Department of Electrical Engineering at the University of Manchester in October 1940, and graduated

with first-class honours in 1943. He then joined the Royal Navy as midshipman and successively became sub-lieutenant and lieutenant, his main concern being with anti-submarine warfare. He returned to the staff of the Department in 1946, and was appointed senior lecturer in 1953. His first researches were in the field of electron optics, but in 1947 he began to take an interest in servo-mechanisms. During the ten years that have elapsed since then he has built up an active research group specializing mainly in non-linear servo-mechanisms. Dr. West has become a well-known authority in this difficult field, to which he, and his group, have contributed a considerable body of published work. Arising out of this work he was awarded the degrees of Ph.D. in 1952 and D.Sc. in 1957. Alongside this research activity he has built up an excellent third-year undergraduate course. In connexion with this course he has published a very successful text-book and he has a further book in course of publication. Dr. West's activities extend well beyond purely academic circles: he is a member of several committees concerned with automatic control and is in close touch with industry through his consulting activities. He has taken an active part in the work of the Institution of Electrical Engineers and received a Premium of the Institution in 1956 for his work on non-linear control systems. He has been a member of the North-Western Centre Measurement and Control Section Committee, of which he was chairman during 1955–56, and has been an invited speaker at several international conferences on automatic control.

Biohistorical Institute of the University of Utrecht: Dr. Frans Verdoorn

Dr. Frans Verdoorn, managing editor of the Chronica Botanica Co. and secretary of the International Biohistorical Commission, has been appointed director of the new Biohistorical Institute of the University of Utrecht, The Netherlands. This Institute, now being set up in conjunction with Prof. Lanjouw's Botanical Museum and Herbarium, will concern itself with the cultural, historical, other humanistic and related aspects of the pure and applied sciences of life, with special reference to the plant species. Born in The Netherlands and originally a cryptogamic botanist, Dr. Verdoorn later engaged mainly in editorial and international relations work. After moving to the United States in 1940, his main interests turned gradually to the borderlands between the natural sciences and the humanities and he collected a great deal of information on botanical biography ("Index Botanicorum"), the history of biology, the history of botanic gardens, the Linnæan period, etc., which will now form the nucleus of the new Institute at Utrecht.

Centenary of the British Ornithologists' Union

As part of its centenary celebrations the British Ornithologists' Union (founded 1858–59) is placing two scientific expeditions in the field. The main expedition is to Ascension Island, where a party of four will undertake a thorough examination of the general biology and breeding behaviour of the ten species of sea birds present. Particular attention will be paid to the following points: investigation of the factors influencing the timing of the breeding seasons (known to fall every nine months in one species); comparisons of the feeding, growth, maturation and survival-rates of the young; comparative studies of behaviour patterns in closely related species; population counts and surveys of breeding sites, as a basis for conservation measures and possible future studies; an extensive programme of ringing adults and young. The party left England recently and expects to remain in the field for eighteen months. It will be joined from time to time by visiting scientists, who will work on independent problems. The expedition, which is led by Bernard Stonehouse, of the Edward Grey Institute, Oxford, who has had long experience of biological and meteorological work in Antarctica and Grahamland, will also be taking hydrographic observations. A second expedition is planned to investigate problems of taxonomics and speciation in the Comoro Islands.

Scientific and Technical Man-power in Britain

Several questions relating to scientific man-power were raised in the House of Commons during November 18–19. The Paymaster-General gave the number of scientists now employed in his Department as 162 and his expenditure on scientific research in the current financial year as £1,045,000. Asked whether he would arrange for one Government department to be responsible for maintaining records of the numbers, qualifications and types of appointment held by professional engineers and technologists, the Prime Minister said that the Minister of Labour is already responsible for collecting information about the employment of persons in Great Britain, including engineers and technologists, and that the expense of keeping records as full as those suggested would be disproportionate to the value. Asked if he would arrange for one Government department to be responsible for maintaining records of all emigration of highly qualified scientists and engineers, the Prime Minister referred to an earlier reply of the Home Secretary which stated that in view of admitted deficiencies in the available statistics of emigration to and from the United Kingdom, Government departments interested are making a special review of the information required for official purposes about migration and the means for obtaining it. In reply to a further question as to the accuracy and fullness of the records of emigration, the Prime Minister emphasized the difficulty of obtaining the records, which are undoubtedly desirable, without resorting to compulsory registration, for example; he said he is ready to seek all possible information short of reverting to compulsory powers. On November 20, the Minister of Labour said, in answer to a question whether he would now grant exemption from National Service to science and engineering graduates with second-class honours degrees entering establishments of further education, that he had asked his Technical Personnel Committee to study the proposal.

Russian Scientific Literature

The Department of Scientific and Industrial Research Lending Library Unit is building up a comprehensive collection of Russian scientific and technological literature. At present it is receiving some 220 periodicals regularly from the U.S.S.R. In addition it has received parts of a number of irregular serials, and has catalogued more than 500 Russian books. In all it is probably receiving something over half the current Russian output of scientific and technical literature. The rest is in the

main available only on exchange terms from a number of organizations scattered throughout the U.S.S.R. These exchanges are being developed as rapidly as possible. The main difficulty is to track down what is available and the addresses of producing organizations. The Unit will welcome any assistance in this task. Although the bulk of the Russian literature held is very recent, a service for it is being started. Further information can be obtained from the D.S.I.R. Lending Library Unit, 20 Chester Terrace, London, N.W.1.

Scientific Translation and Languages

A REPORT on "Scientific and Technical Translating and other Aspects of the Language Problem" (pp. 282 : Paris : Unesco, 1957) is the result of collaboration between the Secretariat and 219 persons from twenty-one countries, arising out of a resolution adopted at the seventh and eighth sessions of the Organization's General Conference in 1952 and 1954. This authorized the Director-General "to advise and encourage international organizations concerned with the development and improvement of scientific documentation, standardization of terminology, compilation of multilingual dictionaries, and the improvement of terminology". In the first chapter the magnitude of the problem is appraised and the qualitative aspects of translating are reviewed in the second. Two chapters on methods and organizations for translation and distribution follow and the problems of increasing scientists' knowledge of languages are then discussed. In this connexion there is appended to the report a useful bibliography of books for technical language study. The concluding two chapters deal with the possible use of languages which are internationally understood so as to minimize the need for translation, and with terminology and lexicography. The latter is in continuation of activities initiated in response to a recommendation of the International Conference on Science Abstracting in 1949. There is a general bibliography and also a list of proposals regarding which further expressions of opinion are invited. No decisions have yet been taken by Unesco upon these proposals and the report is to be regarded as a statement of progress put forward in the hope that proposals may be reached for positive action which could be undertaken if funds permit.

Some interesting figures are given in the first chapter of the report. From a random sample of 1,000 scientific periodicals, English appears to be the dominant language, accounting for 436, compared with 144 in German, 126 in French, 53 in Spanish, 93 in other Latin script, 81 in Russian and other Cyrillic, and 36 in Italian. Except in geology and mining, meteorology and palæontology, in which English accounted for only 25 out of 96, this proportion held in all the main subject groups : for example, 32 out of 88 for pure and applied sciences in general ; 24 out of 59 in mathematics and physics ; 23 out of 54 in pure and applied chemistry ; 43 out of 100 in biology, bacteriology, etc. ; 78 out of 193 in medicine, pharmacy, dentistry ; 65 out of 122 in engineering, transport, building, architecture ; 91 out of 185 in agriculture, forestry, fisheries ; and 25 out of 48 in leather, plastics, rubber, textiles, etc. It is also estimated that out of some 4,624,000 scientists and technologists, 1,643,000 can read German, 361,000 Spanish, 2,650,000 English, 1,206,000 French, and 1,131,000 Russian.

Acta Virologica

AN increasing effort is being made to render the Iron Curtain permeable to scientific knowledge. Much of interest is reported in the first number of *Acta Virologica* (Vol. 1, No. 1 (January–March, 1957). Pp. 64. English edition. Annual subscription 30 Kčs. Orders to ARTIA, 30 Ve smečkách, Prague). This journal is edited by D. Blaškovič of Bratislava in Czechoslovakia with A. A. Smorodintseff of Leningrad as sub-editor, and is published quarterly under the auspices of the Czechoslovak Academy of Sciences. It is to appear in two editions, in English and Russian respectively. The articles in the first number, which come from Bratislava (three), Leningrad (two), Warsaw, Peking and Sofia (one each), represent serious contributions to virology. The English is good, as are the illustrations, some of which are in colour, and the journal is well produced. If the standard is maintained, *Acta Virologica* should prove a very worthwhile venture, of much benefit to the subject.

The Woollen Industry

THROUGHOUT the world, the woollen industry has an incomparable record in its efforts to find more and more uses for this natural fibre. These efforts are matched by the exertions the industry has made to improve the wearing quality of the fibre and to find more people who wish to use it. All those concerned must be gratified with the results achieved. The review of the International Wool Secretariat and Wool Bureau Incorporated for 1956–57 shows that wool had a remarkable resurgence during the year, particularly in the United States ; it is still the most popular clothing fibre throughout the world. The United Kingdom remains as the largest wool-producing country in Europe. The work of the education, publicity, trade promotion, economics, and science and technology branches of the International Wool Secretariat and Wool Bureau are described in the review, which is most attractively illustrated. Copies may be obtained from the International Wool Secretariat, 18–20 Regent Street, London, S.W.1, or from the Wool Bureau, 16 West 46th Street, New York 36.

Food Additives

THE use of food additives—with all their attendant dangers—is now so widespread that the World Health Organization and the Food and Agriculture Organization have felt it necessary to set up a joint expert committee to examine the position and advise on the measures needed to safeguard the health of the consumers. Its first report has recently been published (General Principles governing the Use of Food Additives. W.H.O. Tech. Rep. Ser. No. 129. Geneva, 1957. 1*s.* 9*d.*), dealing with the use and abuse of "non-nutritive substances added intentionally to food . . . to improve its appearance, flavour, texture or storage properties". While allowing that such additives may, in certain circumstances, reduce the wastage of food or provide essential aids in food processing, it is clear that without close legal control their use may result in a substantial reduction in the nutritive value of common foods, they may disguise faulty processing and handling techniques, and they may expose the consumers to unknown risks—not only from the intake of substances abnormal in themselves but also from the further possibility that the combined effect of a number of additives in differ-

ent foods used in the diet may produce an undesirable summation of reactions. This small report should prove of very great help to medical officers, administrators and teachers concerned with problems of public health.

High-Level Beach Lines in Morocco

THE study of the high-level beaches occurring along the North African coast has long occupied quaternary geologists. The term 'high-level' rather than 'raised' is used deliberately as it is believed that they are the result of a rising and falling of the sea-level during interglacial and glacial periods rather than of earth movements. During glacial maxima vast quantities of water were locked up in the form of ice sheets and the level of the sea sank; when the warm conditions of interglacial times supervened the ice melted and the level of the sea rose. High-level beaches, therefore, indicate an interglacial period. A number of savants have been concerned with this study and among them must be mentioned M. Georges Choubert, who has contributed an interesting paper (*C.R. Acad. Sci., Paris*, **245**, Sept. 23, 1957) on the correlation between the marine and continental cycles of the Pleistocene period in Morocco. One fact his article shows clearly, and it is a problem which has not yet been satisfactorily explained. The earliest terrace (Sicilian) lies at 90 metres above present sea-level. There was then a fall of the sea with the oncoming of glacial conditions. When the water rose again it only reached 60 metres above present sea-level; and this phenomenon of general lowering continued. As well as the up and down movements of the sea-level, there seems to have been at the same time a steady depletion of the available sea water. Possibly considerable earth movements caused large underwater deeps which had to be filled, but the explanation of this steady fall in sea-level throughout Pleistocene times, apart from the up and down due to glacial and interglacial phases, is a mystery. The phenomenon is not confined to the Mediterranean. M. Choubert also claims to have discovered pre-Günz climatic changes back in the Villafranchian. He equates the latest of these with the pebble culture of Arbaoua. But are any of these so-called early pebble tools really artefacts? A number of workers have recently come to the conclusion that there are no man-made objects prior to the early Oldoway culture.

Griseofulvin in Horticulture

GRISEOFULVIN, a new antibiotic, has now been released by the Government for use in horticulture. Trials have shown it to be highly effective in controlling *Botrytis* (grey mould) in the lettuce crop grown under glass: as a 3 per cent dust, used at approximately 1 oz. per 20 sq. yd., *Botrytis* infection was reduced by some 40–50 per cent, treatment both before and after planting-out giving the best control. Application in the form of a 3 per cent atomizing spray was also successful. The cost of the treatment, where the full value of the crop is assessed at £1,500, would lie between £35 and £52, while the gain to the grower is estimated at £190 per acre. There would also be an increase in size of marketable lettuces from the reduction in infected leaves, and a substantial saving in time and labour spent on trimming. Trials are now in progress on the effect of griseofulvin on other diseases of lettuce, such as downy mildew and damping-off, and will shortly be extended to other crops, including strawberries, raspberries and tomatoes. Griseofulvin is not yet available for sale to growers, but the Murphy Chemical Co., Ltd., Wheathampstead, Herts, is marketing a substance, 'Grisovin', containing the antibiotic, and has issued an illustrated leaflet dealing with the control of *Botrytis* in lettuce under glass with this product. Limited quantities of griseofulvin are available, however, from G. L. Hey at the above address, for research workers in Britain or overseas who are interested in trying the material against species of *Botrytis* or *Mycosphaerella* on a range of crops.

Committee of Inquiry into the Fishing Industry

A COMMITTEE of Inquiry into the Fishing Industry has recently been formed by the Ministry of Agriculture, Fisheries and Food and the Scottish Home Department "To assess, in relation to developments in fishing and the marketing of fish, the size and pattern, and implications, of an economic fishing industry in the U.K., and to report". Members of the Committee are: Sir Alexander Fleck (*chairman*), Mr. H. W. Clements, Rear Admiral R. A. Currie, Sir Alister Hardy, Sir Graham Larmor, Mr. I. W. Macdonald, Mr. George Middleton, Mr. W. B. Reddaway. The secretaries are Miss M. E. Vince, Ministry of Agriculture, Fisheries and Food, and Mr. I. L. Sharp, Scottish Home Department.

Royal Agricultural Society of England Research Medal

THE Royal Agricultural Society of England offers annually a medal together with an award of one hundred guineas for research work of outstanding merit carried out in the United Kingdom which has proved, or is likely to prove, of benefit to agriculture. Recommendations for this award can be made by the heads of university departments, research stations and institutes and other research establishments. No direct application by candidates will be considered. Recommendations for the next award must be submitted to the Secretary, Royal Agricultural Society of England, 35 Belgrave Square, London, S.W.1, before January 31, 1958.

Micro- and Semi-Microchemical Methods

COMMENCING on January 11, a course of twelve lectures and appropriate practical work will be held on Saturday mornings at the Norwood Technical College from 9.15 a.m. to 12.30 p.m. The course is designed to survey the principal branches of chemistry in which small-scale methods have been successfully applied and is particularly suitable for teachers wishing to introduce modern techniques into advanced and scholarship level and degree courses. Further information can be obtained from the Secretary, Norwood Technical College, London, S.E.27.

University News: Bristol

THE following appointments in the University of Bristol have been announced: Dr. D. W. Barritt, as lecturer in medicine; I. W. Cameron, as lecturer in dental surgery (prosthetics); Dr. L. C. Frost, as lecturer in genetics in the Department of Botany; N. St. G. Hyslop, as lecturer in clinical veterinary pathology; Dr. P. M. Llewellyn, as lecturer in physics; Barbara M. Q. Weaver, as lecturer in veterinary surgery.

Among the grants, gifts and bequests received by the University are the following: from the Depart-

ment of Scientific and Industrial Research to the Department of Physics, £4,000 for experimental research in nuclear physics and cosmic radiation, £3,600 for experimental research into flights with free balloons of long duration at 100,000 ft., and £3,100 for work on measurement in relativistic quantum theory; from the National Coal Board to the Department of Physical and Inorganic Chemistry, £1,000 and £750 for the study of the reactivity of carbon surfaces with oxygen and a study of the structure of active carbons, respectively; a bequest from the late Miss Nebendahl of £1,000 to the University's Cancer Research Fund; from the Department of Scientific and Industrial Research to the Department of Organic Chemistry, £866 for research on chlorogenic acid and closely related compounds, and £600 for continuation of research on cell-wall carbohydrates of plums. The University is also to receive a bequest from Mrs. A. M. Fertel of an estate valued at more than £5,000 to found one or more studentships for the furtherance of experimental research in physics, preferably in nuclear physics, to be known as Geoffrey E. Fertel Studentships, in memory of her son, who was a member of staff of the Department of Physics.

Glasgow

Dr. D. C. Gilies has been appointed director of the Electronic Computer Laboratory and is now in residence at Glasgow. He will have charge of the Scottish mercury computer, delivery of which may be expected next year, when it is to be housed in the Chemistry Department.

Drs. R. Hodges and A. I. Scott have been appointed lecturers in chemistry, and Dr. D. H. Watson to an Imperial Chemical Industries fellowship in chemistry.

The Wellcome Trustees have made a grant, of up to £50,000, for the building of a Small Animals Experimental Research Unit at the Veterinary Hospital, Garscube. Work has begun on the second stage of development of the extensions to the Natural Philosophy building.

For the present session four hundred new students (304 men and 96 women) have been admitted to the science departments. Over the University as a whole, the total number of matriculated students now stands at 6,090, compared with about 5,920 a year ago.

London

The title of professor emeritus in biometry in the University of London has been conferred on Prof. J. B. S. Haldane.

Dr. Stephen Dyonis Elek has been appointed to the chair of bacteriology, tenable at St. George's Hospital Medical School, from October 1, 1957.

The Night Sky in December

Full moon occurs on Dec. 7d. 06h. 16m. U.T., and new moon on Dec. 21d. 06h. 12m. The following conjunctions with the Moon take place: Dec. 16d. 18h., Jupiter 2° N.; Dec. 18d. 21h., Mars 1° S.; Dec. 24d. 18h., Venus 6° S. Mercury is visible at the beginning of the month as an evening star low in the west after sunset, but conditions are unfavourable for observation. Venus sets at 18h. 55m., 19h. 10m. and 19h. 10m. at the beginning, middle and end of the month, respectively; during this time its distance from the Earth decreases from 53 to 34 million miles, the visible portion of the apparent disk from 0·428 to 0·201, and its stellar magnitude is about − 4·3. It is a brilliant object in the south-west after sunset; greatest brightness is on December 23. Mars rises at about 5h. 35m. throughout the month; it is in Libra until December 25, when it enters Scorpius, being near β Scorpii at the end of the month. Jupiter rises at 3h. 30m., 2h. 50m. and 2h. 00m. at the beginning, middle and end of the month, respectively, and is east of Spica. The stellar magnitude of Jupiter is − 1·4, its distance from the Earth on December 15 being 550 million miles. Saturn is too close to the Sun for observation. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Dec. 12h. 0h. 23·5m., ω Leo. *m.* (*R*); Dec. 26d. 20h. 33·7m., x Aqr. (*D*). *R* and *D* refer to reappearance and disappearance, respectively. The Geminid meteors are active during December 9–14, but conditions are not very favourable. The Ursids are active during December 21–22, and conditions are very favourable; the radiant is at R.A. 14h. 28m., Dec. + 76° N. The winter solstice occurs on Dec. 22d. 03h.

Announcements

A House of Scientific Technique, which will accommodate more than twenty scientific bodies under the same roof, is to be built in Budapest at a cost of £600,000, to be paid by a government grant. Several stories high, the House, which is due to be completed in 1960, will have club rooms, lecture halls, libraries, a modern theatre, a gymnasium and a restaurant.

The Royal Society is prepared to consider applications from scientific societies for grants towards the travelling expenses of scientists (particularly young scientists in the United Kingdom) attending ordinary or special meetings, or congresses, held in the United Kingdom. Further information can be obtained from the Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1.

The complete proceedings of the International Symposium on Macromolecular Chemistry, held in Prague during September 9–15, will be published in the spring of 1958 as two or three special numbers of the *Journal of Polymer Sciences*.

A Physical Society conference on "Band Theory of Metals and the Structure of the Fermi Surface" will be held in the Imperial College Union, Prince Consort Road, London, S.W.7, on December 19 and 20.

An international colloquium on "Optics in Metrology" will be held in Brussels during May 6–9, 1958, under the auspices of the International Commission for Optics. Further information can be obtained from M. P. Mollet, Comité Belge d'Optique, 128 Rue du Sport, Gand, Belgium.

The Third International Congress on Rheology will be held in Bad Oeynhausen, Germany, during September 23–30, 1958. Contributions are invited for this Congress and a 100–200 word abstract of any proposed paper should be sent by January 1, 1958, to the Congress secretary, Dr. W. Meskat, Bahnhofstrasse 9, Dormagen, Near Cologne.

Erratum. In the communication entitled "Further Radio Observations of the First Satellite" by Norman Lea in *Nature* of November 9, p. 943, the lower figure on the vertical axis of Fig. 1 should read 1,600 [c./s. above 40 Mc./s.], and not 1,500 as printed.

RECENT SOLAR ACTIVITY

By Dr. M. A. ELLISON
Royal Observatory, Edinburgh

THE present maximum phase of the sunspot cycle is outstanding in many respects. The Zurich relative sunspot numbers (provisional) for the first ten months of 1957 were: 152, 117, 157, 175, 165, 206, 194, 163, 244, 263. These high values for September (244) and October (263) are quite exceptional. If we look back to the beginning of the series in 1749, the only other monthly means which have exceeded the 200 level were those of May 1778 (239), December 1836 (206), May 1947 (201) and November 1956 (203). We may thus regard the timing of the opening months of the International Geophysical Year as particularly fortunate: to have caught so great a peak of solar activity within its net was a considerable achievement of planning.

The high sunspot numbers of 1957 have been contributed mainly by the occurrence of large numbers of small and medium-sized spot groups. On many days in September and October there have been upwards of twenty such groups present on the disk at one time. On the other hand, the giant *F*-type sunspots which were such a characteristic feature of the last cycle, in the years 1946–51, have been noticeably few. It is spots of this type, possessing complex magnetic fields ($\beta\gamma$ and γ), which give rise to the most intense (3+) solar flares, and these have likewise been less frequent than the high sunspot numbers would lead one to expect.

Another unusual feature has been the continued appearances of occasional spots in high latitudes, such as are characteristic of the early years of the cycle. One of these groups, in latitude 46° S., crossed the central meridian on September 15 and lasted for at least seven days.

September also provided something like a record in magnetic activity: there were, in all, six great storms with sudden commencements, beginning on September 2, 4, 13, 21, 22 and 29. Two regions showing high flare activity (one in 20° N. and the other in 30° S. latitude) crossed the Sun's central meridian on August 31, and to these must be attributed the great geomagnetic disturbances during September 2–5. One of the few *F*-type sunspots developed rapidly from September 14 onwards, crossing the central meridian on September 19. This region generated a high level of activity—at least a dozen flares were observed here in the class 2 and 3 categories—and was undoubtedly responsible for the magnetic storms on September 21 and 22. Another active group, with central meridian passage on September 27, was the probable cause of the storm on September 29.

Prof. J. Bartels reports that, for September, the monthly average of the daily planetary magnetic amplitudes, *Ap*, in the usual unit of 2 gamma, was 49. The next highest monthly averages in the available series (1932–33, and 1937 to date) were 40 (September 1951) and 37 (March 1940). September had three days with $Cp = 2{\cdot}0$ and five days with $Cp = 1{\cdot}9$.

Some thirty-six sudden ionospheric disturbances (cases of *D*-layer absorption due to solar flares) were recorded in Britain during daylight hours in September. Many of these produced severe fade-outs on 18 Mc./s. and lower frequencies, such as are usually associated with flares of classes 2 and 3. *F*-layer radio reception with North America was particularly disturbed, especially at the times of the large magnetic storms referred to above.

Although the sunspot number for October exceeded the high value in September, active solar regions were less pronounced and their terrestrial effects were on a considerably smaller scale. A 3+ flare, observed at the McMath-Hulbert Observatory, reached its peak intensity at about 17h. 00m. on October 20. This outburst would appear, on a provisional view, to have been the most likely source of the magnetic storm particles which began to affect the ionosphere on the afternoon of October 21.

ECOLOGY OF GRASSLANDS

ON September 11 in Dublin, Section K (Botany) and Section M (Agriculture) of the British Association held a joint session under the chairmanship of Prof. J. Doyle on "The Ecology of Grasslands". Mr. C. E. Hubbard opened with a paper on "Genetical and Ecological Variation of the Components of Grasslands in the British Isles". Speaking as a taxonomist, Mr. Hubbard pointed out that while the botanist was primarily interested in characters distinguishing taxa and especially those indicative of relationship, the agriculturist was essentially concerned with characteristics likely to be of value for grassland improvement and only those varieties likely to be of economic importance were of prime interest to him. Variability in grass populations had long been recognized. A. F. Gray in 1821 recorded seventy-five varieties of wild British grasses, while nowadays the number of intraspecific variants recorded exceeded four hundred. Mr. Hubbard then presented a classification of grass variants and distinguished between those of some taxonomic significance and others of a more trivial nature. Diseased or abnormal states were seldom of any ecological or genetical significance. Colour variants, however, might be due to ecological or genetical factors: the colour-spikeleted forms of *Deschampsia caespitosa*, for example, were definitely genetical in character. Albinism, on the other hand, when almost complete, usually led to early death. Partial albinism producing variation, however, was often an unstable condition, and reversion was not unusual. Anatomical variation included the pruinose and glaucous condition due to a waxy surface layer or a thick cuticle, and the rigidity or otherwise of a grass depending on the amount and arrangement of sclerenchymatous tissue. This last condition was probably of ecological significance only. The degree of hairiness of a grass was a very variable factor. Some genetically fixed hairy variants existed, but the range of hairiness of the spikelets found, for example, in a population of the microspecies of the *Bromus mollis* complex was doubtless due to hybridization. A number of trivial

modifications in the spikelets, such as extra florets or the presence or absence of awns, appeared in some instances to be due to edaphic factors.

There were many variants distinguished by differences in vigour and size which occurred in a number of polyploid complexes. The collective species—*Agrostis stolonifera*, *Phleum nodosum* and *Dactylis glomerata*—provided examples of paired genetical variants with distinct ecological requirements and size differences. Differences in spikelet size might be due either to genetical or ecological factors.

In a closely grazed grassland the constituent grasses under cultivation as spaced plants showed obvious distinctions in growth form. These had arisen as a result of different forms of managements and maintained their special characteristics under cultivation. Differences in growth-rate and flowering time of geographical races of herbage plants provided grazing over a longer period than single strains when sown together.

The question of self- and cross-fertility was then considered by Mr. Hubbard. It had been noted that most annuals were self-fertile, whereas many perennials were cross-pollinated and often self-sterile. Annuals, as might be expected, tended to have fewer outstanding variants. The polymorphism seen in perennials might arise from intraspecific cross-pollination, interspecific hybridization and some intergeneric crossing. Of interspecific hybrids, thirty-one were known in the British flora, occurring in fourteen genera, six of them annuals and twenty-five perennials. The outstanding polymorphism of *Molinia coerulea* was probably due to ancient hybridization. Cytological investigation here was highly desirable. In the British Isles nine intergeneric hybrids were known involving five or six pairs of genera. Most of them were rare, but one of them, *Festulolium loliaceum*, was widely distributed.

The cause of some outstanding examples of variability might be due to the presence of two or more members of a polyploid series in a taxon. For example, *Holcus mollis* included strains with twenty-eight, thirty-five and forty-two chromosomes; and it was possible that polyploidy might account for other species exhibiting well-marked morphological differences associated with special habit preferences.

The phenomenon of apomixis demonstrated in Scandinavia for *Poa pratensis* did not appear to have been proved experimentally in Britain, but it was probable that the position was similar. It appeared feasible that variation in species of *Calamagrostis*, *Deschampsia*, *Sieglingia* and *Puccinellia* might also be due to apomixis.

Finally, Mr. Hubbard outlined the possible development of natural grassland in the British Isles. Grasses from south and east following retreating ice-sheets of the last Ice Age produced a genetically mixed basic stock which became augmented by accidental introductions and later by intentional additions by man. Plant-breeding stations continued to distribute improved strains which were gradually replacing the indigenous strains in ancient pastures and meadows. Whether it was desirable to replace such strains, selected naturally through a long period of time, by a few selected strains was a debatable point. Mr. Hubbard contended that native strains in Britain should be preserved in as many regions as possible as a reserve from which to make selections for the grasslands of the future.

Prof. M. J. Gorman then followed with his paper on "The Influences of Biotic Factors on Natural and Semi-natural Grassland". He dealt specifically with the permanent grasslands of Ireland and opened by referring to the extent of pasture, old meadows and rough grazings which had remained undisturbed for long periods. The character of herbage was primarily dependent on the nature of the soils, but was ultimately determined by management. What the ecologist called the biotic factor was in a general way what a farmer described as management. The grazing animal, mowing, harrowing and all differential treatments were contributing factors. The intensity of grazing in the Curragh, for example, kept the heather under control and it was seen only at the margins. In Ireland, grass grew readily in response to a sufficiency of rain uniformly distributed. The soil varied and with it the primary vegetation. On poor soils the plants were of poor stature and adapted to poverty conditions. On the richer soils the plants were of good stature, such as perennial rye grass, meadow fescue, tall fescue and tall oat grass.

However, it was the management, or the biotic factors, that ultimately determined the botanical composition of the sward. The actual quantity of fodder produced was dependent on the soil and rain, but the botanical composition of the sward depended ultimately on the grazing animal. The animal operated in response to the relative palatability of the species present, and this was the more important factor in determining the balance of plants in the community. Linnæus's experiments, more than two hundred years ago, on palatability were unfortunately conducted on plucked plants which were then offered to the animals. It was known that animals would eat almost any plant that was offered to them, even poisonous species. They would devour ragwort in hay, yew clippings, and poisonous roots thrown up by drainage operations. In the growing condition such plants rarely caused casualties. The most palatable of grasses appeared to be timothy grass and red fescue, whereas the bents seemed to be less appetizing and for that reason tended to dominate very old pastures. The grazing animal, in fact, had left its imprint on the entire countryside. In recent years the dearth of rabbits had meant the disappearance of ragwort in certain areas, since grasses such as red fescue had been able to develop and crowd it out.

Prof. Gorman then showed colour slides of what he described as typical grasslands and some showing biotic factors at work. Many in the audience were horrified at the various shots of herbage which appeared to be dominated by such weedy species as the bulbous buttercup, ragwort, *Centaurea scabiosa*, *Leontodon*, thistles, *Ulex gallii* and others. Prof. Gorman conceded, however, that grasslands of high quality existed in various parts of Ireland, but at the same time gave the impression that such weed-infested areas were not uncommon. The unsatisfactory state of such grasslands had apparently been due to overgrazing by different animals at different times, with the consequent domination of ungrazable and unpalatable species. Although much could be done by liming and the use of fertilizers, only improved management and effective weed control could successfully deal with the problem, though long years of neglect had added to the difficulty. Much expense and labour would be necessary to carry out what must inevitably prove to be a long-term project.

The Weeds and Seeds (Ireland) Act passed by Parliament in 1908 endeavoured to cope with the problem, but in spite of heroic efforts the success of the Act as a 'biotic factor' had been strikingly unspectacular.

Dr. R. F. Hunter, of the Hill Farming Association, was unable to deliver in person his paper on "The Pasture–Animal Relationship on Hill Grazings", and Mr. A. R. Wannop, director of the Association, read it for him. The paper dealt with hill sheep farming, and in particular the management system known as the border hefting system. This prevailed wherever the stocking intensity lay between one and a little less than two and a half acres per sheep. The flocks were maintained throughout the year on the hill ground, with perhaps a little hay in severe weather. A representative heft included about 150 ewes, and on the particular heft selected for study there were about 130 ewes plus hoggets on an area of about 250 acres. The plant communities included *Nardus*, *Calluna*, *Molinia* and *Agrostis–Festuca* combined with bracken. Experiments were carried out to determine the relative grazing values of these communities. The attention given by the sheep to a particular community was assumed to be a measure of its value. The work was carried out at Sourhope in the Cheviot Hills on a heft sloping up from 900 ft. altitude to approximately 1,750 ft. The sheep were observed from a hut in which was arranged a piece of apparatus designed by Dr. Hunter and christened a 'sheeposcope'. This consisted of a powerful telescope, covering most of the heft, with which was coupled a mechanism capable of plotting the exact position of any animal on a map of the area. It was possible to plot with great accuracy the exact position of all the 150 or so sheep in 10–15 min. Observations, started in September 1956, were made once every hour from dawn until dusk at approximately weekly intervals. Meteorological data were also assembled to determine whether or not sheep behaviour had any connexion with meteorological events.

A number of graphs illustrating the results of the observations on particular plant associations were then shown. It was seen that on the *Nardus* areas, 5 per cent of the total heft, 16 per cent of the sheep were observed. As an index of grazing intensity, the figure of 100 was allotted to a community which was neither favoured nor disfavoured. A figure less than this indicated an avoidance; one greater showed a preference. The grazing of grass below bracken was generally high, since bracken was only about 2 ft. tall and not particularly dense. Variation in grazing intensity was seasonal, being high during September–October and again during March–April. The graph for Molinetum showed a low grazing intensity with some degree of seasonal variation and was definitely not favoured by sheep. Another community consisting of a mixture of *Molinia*, *Juncus squarrosus* and heather, the latter being dominant, also showed a low grazing intensity. The Nardetum curve demonstrated a consistently low grazing intensity, being favoured by the sheep only in the winter. On the other hand, the *Agrostis–Festuca* community had a high intensity throughout the year.

Dr. Hunter had compared his results with similar observations carried out during 1950–52 in the Lammermuir Hills, and, in general, results showed a fair correspondence. Such discrepancies as occurred were explained by the differences in percentage composition of the communities of the corresponding hefts. It was concluded that variation in grazing intensity was modified according to the types of communities and the varying proportions they bore to the heft as a whole. Two broad generalizations arose from the results. First, wide differences existed between the grazing intensities of different communities. Secondly, the seasonal variation in intensity appeared to be a characteristic of the community whenever it occurred in association with others.

Dr. Hunter's paper then discussed the connexion between these conclusions and the work of the ecologist and those concerned with the improvement of hill pasture. The botanical composition of the pastures would obviously be affected by wide differences in grazing intensities. The improvement of these hill pastures, however, presented a number of problems. Should one tackle the heavily grazed communities or those which under free grazing conditions are little utilized? It was Dr. Hunter's opinion that an improvement of the *Molinia* and *Nardus* areas would be advantageous. Nevertheless, in improving pastures there would be difficulties in fencing off improved areas to control the grazing. Many questions remained unanswered. It was concluded, however, that an understanding of the grazing preferences of sheep under free-ranging conditions might help to predict whether the improvement brought about would be utilized in such a way as to lead to an improvement of overall utilization of the pasture as a whole.

The session ended with a long and spirited discussion on many of the points raised by the speakers.

F. BALLARD

FUNDAMENTAL RESEARCH ON PAPER-MAKING FIBRES

THE activities of the Technical Section of the British Paper and Board Makers' Association are usually deliberately organized so as to appeal to all classes of members. The symposium entitled "Fundamental Aspects of Fibres and their Treatment for Papermaking", held at Cambridge during September 23–27, was therefore a unique departure from custom. Its object was to assemble together prominent workers in this field from all parts of the world, for the purpose of presenting papers for discussion at the highest possible academic level.

The success of the experiment may be judged from the fact that of some two hundred persons attending, about one half were from overseas, and these included many well known for their work in specialized fields of fibre research. Seventeen overseas nations were represented.

Social features were provided in the form of evening conversaziones, a theatre visit, and an excursion to Ely and Norwich. These, however, appeared to supplement opportunities for discussion on the more serious business of the symposium rather than to provide a relaxation, and this despite the full official programme. To many of the overseas visitors the atmosphere of Cambridge, despite the bad weather, was an attraction in itself; and the lecture hall and residential facilities made available by the University authorities were greatly appreciated.

After Sir Geoffrey Taylor had welcomed the participants, Session 1, dealing with the morphology of pulp fibres, was opened under the chairmanship of Dr. W. Holzer. Prof. A. Frey-Wyssling (Switzerland),

in discussing the general structure of fibres, pointed out that the young differentiating fibre has a very thin cell wall consisting of an amorphous matrix of pectic and hemicellulosic material reinforced by about 5 per cent by volume of cellulosic microfibrils (diameter about 250 A.) arranged in a dispersed interwoven texture. This may be described as the primary wall. As growth proceeds, more of the microfibrils are produced, and the character of the wall changes. Indeed, it is possibly then identical with the outer layer of the secondary wall, a lamellated structure in which the microfibrils are closely packed, touching laterally and forming characteristic fasciations. The elementary fibrils appear to be ideally crystallized, the space between them being filled partly with paracrystalline cellulose and partly with alkali-soluble non-cellulosic material. Throughout fibre growth a tertiary lamella exists at the boundary between the living cytoplasm and the fully differentiated secondary wall.

This overall picture of fibre structure provided a background for the following more detailed treatment of the subject. Dr. H. Bucher (Switzerland) was concerned with discontinuities in the microscopic structure of wood fibres, as disclosed when they are allowed to swell in dilute alkali and then crushed. Such work indicates an actual discontinuity in the constitution of the secondary wall of coniferous wood fibres; a concept which existed at one time but which has been abandoned in recent years. The presence of a tertiary wall having a distinct microscopic structure is an important concept, since it appears to influence such important papermaking considerations as stability, elasticity and water sorption. H. W. Emerton (British Paper and Board Industry Research Association) then dealt with the structure of the outer secondary wall. Differences in the terminology of cell structure became apparent from time to time during the symposium, but many speakers, including Emerton, regarded the secondary wall as the series of coaxial layers characterized by close lateral packing and parallel alignment of their fibres within the primary wall. The polarizing light microscope shows that in the outermost (*S*1) and innermost (*S*3) layers of the secondary wall the fibres have an almost transverse direction; while in the middle layer (*S*2) they are almost longitudinal. Some excellent micrographs were used for showing that when pine tracheids are pulped by the kraft process there is a tendency for an outer wall to part cleanly and readily from the rest of the wall over a wide area. This wall (believed to be *S*1) consists of two counter-rotating sets of striations, symmetrically disposed about the axial direction. There is experimental support for the hypothesis that the two helices are in distinct layers. Markings in the axial direction which occur chiefly at the edges of the cells were a striking feature of the micrographs. However, it is not yet certain whether they are bundles of fibrils or creases resulting from the drying of the specimen.

The fine structure of the cellulose fibrils was discussed by Dr. B. Rånby (United States), starting with the concept (based on X-ray diffraction data for crystalline cellulose) that the cellulose chains form fairly straight and flat ribbons in the cellulose lattices. The flexibility of cellulose chains is thus limited mainly to the glycosidic bonds between the glucose units, where rotation is easier. The electron microscope provides evidence that hemicellulose is dispersed between the cellulose fibrils throughout the whole cell wall, and the ease of dispersion of pulp fibrils rich in hemicellulose into fibrils suggests that there are few cellulose chains linking one fibril to another—a conclusion which Rånby felt should be treated with caution. He also discussed the crystallinity of native cellulose, pointing out that it can be assessed from the regions of low order (that is, those most accessible to chemical reagents), the average width of the crystalline regions, and the lattice order, which varies according to the biological origin of the material.

The discussion on this session produced general confirmation of Emerton's work. The important point was made that elementary fibrils cannot be disintegrated solely by mechanical means, but that the hydrogen bonds must first be destroyed by solvent action. Moreover, fibrils of the same dimensions in the primary and secondary walls do not necessarily appear to be otherwise identical. There is insufficient difference in chemical composition between the secondary and tertiary walls to account for the differences in their behaviour.

Session 2 (chairman, Dr. J. Grant) dealt with the chemistry of pulp fibres and was introduced by Prof. E. L. Hirst (Edinburgh) with a concise survey of existing knowledge of the chemical structure of the hemicellulose group. Dr. L. Jörgensen (Sweden) then presented data for the carbohydrate compositions of spruce pulps prepared by a variety of processes over a wide field range. It was then possible to relate the hemicellulose content with the strength values of the pulps. Dr. P. Lange (Norway) discussed his work on the distribution of cellulose, hemicellulose and lignin in the cell walls of spruce, birch and cotton. His paper introduced some elegant techniques; notably the use of interference microscopy, histo-radiography and absorption microphotometry in the visible and ultra-violet regions. The results show that the compound middle lamella and the secondary wall are the main locations for the lignin and carbohydrate constituents, respectively. The most rapid change in lignin concentration occurs in the outer secondary wall, where it falls from 60–90 to 10–20 per cent in the lumen (for spruce). Thus, in general, the cell wall of wood is highly ordered around the lumen and becomes more amorphous as the middle lamella is reached. Dr. G. N. Christensen presented a paper by H. E. Dadswell, A. B. Wardrop and A. J. Watson (Australia) on what is known as reaction wood, that is, wood which is anatomically different from normal wood, having developed in leaning or crooked trunks and in branches. In the softwoods such wood (compression wood) has a relatively high lignin, and a low cellulose content. The reverse applies to reaction hardwood (tension wood) and in addition its pentosan content is very low; hence its poor papermaking properties. Strangely enough, the mechanical pulps from tension and compression woods are superior and inferior, respectively, to those obtained from the corresponding normal woods.

The discussion on this session emphasized the importance of the acid hydrolysis of cellulose as a guide to the degree of crystallinity. Such work shows that the interfibrillar material is accessible to hydrolysis and therefore amorphous, and that it consists mainly of mixed hemicellulose. There is also evidence that attack by hydrolysis is assisted by slip-planes introduced by tension wood. While self-contained in

a chemical sense, the discussion gave the impression that it is not yet possible to link up the physical and chemical evidence on cell-wall structure.

In Session 3, which, under the chairmanship of Dr. H. F. Rance, dealt with bonded-fibre assemblages, the contributions took a more practical form in that they dealt with paper as distinct from fibres. Prof. B. Steenberg (Sweden) presented a critical review of the relationship between beating and the mechanical properties of paper. He indicated that the ultimate strength properties are determined essentially by the less-damaged fibres and the contacts they make with one another. Prof. W. Brecht (German Federal Republic) dealt with the effect of beating on the important practical property of hygrostability of paper, and the influence of paper composition, thickness and density. It was concluded that inter-fibre shrinking, which is a consequence of surface tension effects between individual structural elements, is promoted by beating since this produces suppleness. Single fibre shrinkage, on the other hand, is practically independent of beating, but its effect is transferred to the final sheet to a degree which depends on the extent to which the fibres are in contact.

A paper by Dr. H. Corte (German Federal Republic) dealt with the measurement of the porous structure of paper and its modification by beating; and L. Nordman (Finland) discussed strength of bonding in paper in terms of the energy required to break the bonds in an area of unit size. For such measurements the optical method based on the theory of Kubelka and Monk is preferred, the bond-strength being determined from the slope of the line relating the increase in scattering coefficient and the irrecoverable energy loss in a straining/destraining cycle. The results are similar to those deduced from the work of Nissan on strained hydrogen-bonded materials.

The stepwise pattern of Nordman's curves relating increase in reflectance and strain was related by C. R. G. Maynard, during the discussion, to the formation of opaque patches made up of criss-cross lines when transparent paper is subjected to strain.

Session 4, on the process of beating (chairman, Prof. B. Steenberg), comprised six papers which were intended, so far as possible, to collate the conclusions of the preceding sessions. Dr. W. Gallay (Canada) introduced it with a review of aspects of the theory of beating, and Emerton provided a short sequel to his paper in Session 1 when dealing with the significance for paper-making of the outer secondary wall (or primary wall as a number of speakers felt it should now be called). Prof. H. W. Giertz (Norway), in a study of the effects of beating on individual fibres, dealt primarily with swelling and fibrillation phenomena. Although it is difficult to measure the degree of swelling, it has been shown that it increases with beating. While, therefore, swelling is a necessary condition to obtain paper strength, it has not been possible to correlate these two properties. In general, similar conclusions apply to external fibrillation. A combined swelling and staining technique was used to render the primary wall visible, and thence to show that removal of the primary wall has a drastic influence on the bonding capacity of the fibre.

Prof. G. Centola and Dr. D. Borruso (Italy) then discussed the influence on beating of certain electrolytes and substantive azo-dyes. As a rule, electrolytes reduce the beating rate (as compared with distilled water). On the other hand, benzidine type azo-dyes greatly accelerate beating and the development of mechanical properties, and when added to the beaten pulp produce an increase in wetness without appreciable change in strength. Extraction of the dye from the beaten pulp reduces the wetness.

Dr. J. A. Van den Akker (United States) applied energy considerations to the beating process under idealized conditions. He found an energy requirement of 0·01 kWh. per ton of pulp for the production of 'sub-microscopic fuzz' (fibrillation), that is, only 0·0025 per cent of the total energy expended in a typical beater or refiner. For the loosening of the internal structure of the fibres (swelling) and for cutting, the respective energy requirements are only 0·4 and $2{\cdot}7 \times 10^{-5}$ kWh. per ton. The wastage of energy in the form of heat during beating has always been regarded as inevitable; these figures should, however, shake the complacency with which it has been accepted.

The concluding paper, by O. L. Forgass, A. A. Robertson and Dr. S. G. Mason, read by Dr. S. G. Mason (Canada), dealt in a masterly way with the hydrodynamic behaviour of paper-making fibres, under the headings of flow of pulp suspensions, coherent fibre networks, and the flexibility of single fibres. The study of flexibility is of particular interest because of its relationship to fibre entanglement and wet-web properties. The method of measurement adopted makes use of the characteristic rotational orbits described by fibres suspended in a liquid subjected to laminar shear. The flexibility was found to increase as the lignin was removed; with increase in the length of fibre; and on beating.

A point raised in the discussion (which indeed is applicable to the whole of the symposium) is the importance of making clear when the term 'fibre' is used in a general sense—and when used for describing wood fibres only, as was usually the case. It was pointed out, for example, that the conclusions regarding the relative unimportance of external fibrillation in producing strength is most unlikely to apply to well-fibrillated rag fibres.

A brief summing-up by Dr. H. F. Rance brought this highly successful event to a close.

JULIUS GRANT

THE BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION

THE Association opened its doors to eight hundred visitors from member-firms, academic and government agencies, and non-member organizations during the week beginning October 7. Each day a distinguished scientist gave a lecture to the visitors after luncheon in a marquee on the lawn. Fortunately for all concerned, the weather remained uniformly good over the period. The chairman of the Association, Mr. J. E. C. Bailey, entertained the speakers and other distinguished guests at a dinner held in London on the evening of October 9.

The main research programme of the Association, as approved by the Research Advisory Committee, was exemplified by exhibits of the investigation of

the structure and control of thin films, ultrasonic and electromagnetic flowmeters, applications of semiconductors, and the design of a specific microscope objective. These formed but a part of the seventy-seven exhibits, covering many aspects of the Association's work. Of particular interest, as indicating the importance of giving as much freedom as possible to the individual scientist, was the demonstration of a chemical balance which used flexure pivots in place of knife-edges. This development had no place in the research programme, but although the investigation is still in its early stages, a promising degree of robustness and sensitivity has been achieved. Another exhibit of potential value was the moisture-sensitive ceramic element. This was demonstrated, measuring humidities in the 0–1 per cent region to about 0·02 per cent. The instrumental applications of graticules, devices which started as scales and now form an essential part of certain automatic control processes, are becoming more numerous every day. The exhibits concerned with graticules covered the whole field of their manufacture and application. British thermometer manufacturers now have at their command a method of making permanent markings on many of their products. The process for doing this, developed by the Association, was the subject of another exhibit. Pneumatic gauging, as developed by the Mechanical Department, excited considerable interest.

The extent of the services provided by the Information Department came as a surprise to many visitors, particularly the range of technical inquiries handled by the scientific staff of the Department. Working models of flexure pivots, illustrating devices described in one of the Department's publications, aroused much interest.

The speaker on October 7, Dr. T. E. Allibone, took as his subject "Black and White Elephants at Aldermaston". In the course of his lecture he described many discoveries and inventions made in his own laboratories which were apparently of little use, but had afterwards turned out to have considerable value. On October 8, Sir John Cockcroft spoke about "Nuclear Instrumentation" and directed attention to the enormous field for instruments which was being created by the planned reactor programme. On October 9, Prof. Casimir, from Holland, gave his audience a peep into the future by discussing "Atoms as Units", describing how atomic properties could be used as standards of length, time, electric charge and magnetic induction. Dr. Ponte, of Paris, gave a more detailed account of a particular branch of instrumentation on October 10. His subject, "Quartz Oscillators and their Limitations", was illustrated by slides of modern time-measuring equipment. He showed that an accuracy of 1 part in 10^9 was now feasible with small, robust equipment. On October 11, Prof. S. Tolansky demonstrated the power of phase-contrast microscopy by means of many photographs of the detail of crystal structure in metals, convincingly illustrating that for the detection and measurement of the contours of a surface the optical method is comparable with the electron microscope.

A noteworthy feature of the open days was the exhibition of members' products to which the Research Association had made some contribution. It was a kind gesture on the part of the members and one which is bound to have a good effect on the morale of the staff thus to acknowledge some of the benefits which have accrued as a result of the Association's work.

CONTROL OF ADMINISTRATIVE TRIBUNALS

IN opening a debate in the House of Commons on October 31, in which the House took note of the report of the Franks Committee on Administrative Tribunals and Enquiries, Mr. R. A. Butler said that the Government is concerned to accept as many of the recommendations of the report as possible. Nevertheless, it wishes to obtain the views of members on certain of the findings and particularly in the light of the three guiding principles of openness, fairness and impartiality. The Government believes it would be possible to accept wholly or substantially the majority of the detailed recommendations, while striking a just balance between the rights of the citizen and the efficient discharge of the country's business. The Government proposes to set up a single Council on Tribunals which will be appointed jointly by the Lord Chancellor and by the Secretary of State for Scotland, with a special committee or panel of the Council to deal with matters of special concern to Scotland. The Council would be consulted before establishing any new tribunal and the Government would refer to the Council various recommendations made by the Franks Committee.

It is also proposed that, in general, chairmen should be appointed by the Lord Chancellor in England and Wales, and by the Lord President of the Court of Session in Scotland, and the Government agrees that for the most part it is desirable that chairmen of tribunals should have legal qualifications. The opinion of the House of Commons is to be obtained regarding the proposal to entrust adjudicating functions of county agricultural executive committees to new independent tribunals, with appeal to the Land Tribunal or to the Scottish Land Court. In future, it is proposed to appoint inspectors only after consultation with the Lord Chancellor, and the Minister would be free to dismiss chairmen only with the Lord Chancellor's consent. Mr. Butler said that the Government is also prepared to arrange for publication of inspector's reports and promised that in future responsible Ministers would ensure that more is done to make the policies for which they are responsible more widely understood, that people are told where they can find the information which may help them, and that authorities will be required in future to see that their case is properly set out before an inquiry opens. The statement was generally welcomed, and in replying on the debate the Attorney-General stressed the advisory functions of the proposed Council.

EFFECT OF RADIATION ON HUMAN HEREDITY

A STUDY group, set up by the World Health Organization in Geneva to consider the effect of radiation on human heredity, has presented its report to the United Nations Scientific Committee on Atomic Radiation; in shortened form, the report has been prepared as a special feature of the *Chronicle of the World Health Organization* (11, No. 8; August 1957).

Each member of the group was acutely aware of the existing gaps in knowledge and drew up an inventory of problems which will need to be investigated by geneticists, nationally or internationally.

Spontaneous and artificially induced mutations, particularly the kinds of mutation produced by various doses and types of radiation, applied at different stages of the life-cycle under a variety of conditions and utilizing different kinds of organisms, need further examination. The role of changes in the hereditary material of somatic cells in the genesis of leukæmia and various neoplasms could be elucidated. This is now possible owing to the recent developments in tissue-culture techniques. The means of protection against mutagenic agents needs attention. New and improved techniques for the identification of mutants, many of which remain unrecognized at the present time, need development. The manner of gene action is of importance. Dominance, synergism and other forms of gene interaction, including the role of the environment, are important in appraising the effects of radiation and should be further studied in both man and animal.

Factors such as natural selection in populations through the collection of demographic and experimental data should be studied. This type of research is indispensable if the genetic structure of past and present human communities is to be understood and future trends are to be predicted.

Patterns of mating in human populations, such as inbreeding and their genetic implications, are important problems which need solving.

Twin studies in man which are known to be helpful for the understanding of many problems of human heredity offer a large field for research.

The frequency of diseases with a significant genetic component, with particular reference to their epidemiology, needs to be determined. Central registration of data on human inbreeding and hereditary diseases is believed to be of the utmost importance.

Populations of special genetic interest, such as relatively stable, primitive communities, long isolated by geography or culture, and communities exposed to unusually high background radiation should be studied.

The genetic mapping of human chromosomes is also of importance. Cytochemistry and human cytology, particularly investigation of the ultramicroscopic structure and chemical composition of the hereditary material and of the manner in which this is altered by irradiation and other mutagens, and the development of new statistical methods for analysing the results obtained from research in human and experimental population genetics are also valuable fields for further research.

Investigations capable of throwing fresh light on all these problems will involve great effort in many countries and a great expansion of general and *ad hoc* research in genetics and other fields of biology with the closest possible collaboration between those working in the experimental and human fields. The report of the study group emphasizes that "there is at present an insufficient number of institutions where an adequate training in genetics, particularly in human genetics, can be given". The group believes that "medical undergraduates should all receive training in genetics and teaching should be co-ordinated with that in radiology and in the use of radioactive substances in medicine, so that the genetic hazards of diagnostic and therapeutic procedures are thoroughly understood. Medical men training as radiologists should have specific, more advanced, instruction in genetics. Health physicists, radiological physicists and radiological technicians should also receive instructions in genetics as part of their technical training".

The study group was particularly concerned about the genetic hazards of radiation from sources used in medicine, industry, commerce and experimental science. As the report puts it: "Both as an approach to control and as providing basic background information for relating quantitatively radiation exposure and effects on man, it is essential that methods be found of recording exposures to individuals and populations however difficult this may prove.

"There is reason to believe that radiation exposure can be much reduced; those in charge of sources of ionizing radiations should always ensure that there is adequate justification for exposing individuals to doses, however small. On account of the danger to offspring resulting from irradiation of the gonads by X-rays, consideration should be given to determining what efficient means of shielding the gonads could be devised and brought into general use. In addition, in every exposure, the X-ray beam ought as far as practicable to be directed so that a minimum of radiation reaches the gonads."

MEASUREMENT OF SMALL QUANTITIES OF FLUORIDE WITH THE HELP OF FLUORINE-18

By Dr. J. H. FREMLIN, Dr. J. L. HARDWICK and J. SUTHERS
Department of Physics and Department of Dental Surgery, University of Birmingham

IN the course of investigations of the uptake of fluoride ions by teeth, we wish to measure the concentration of fluorine in small samples of enamel and of various aqueous solutions. Colorimetric methods will work at low concentrations (down to less than one part per million) but need samples of at least several millilitres. The more convenient methods may be upset by the presence of phosphates and other salts.

We have developed an isotope-dilution adsorption method which we can use with samples of a milligram or less of solution at the lowest available concentrations. The method is based on the adsorption of fluoride from acid solution by glass. The procedure is as follows. To the solution for analysis is added a small known quantity of fluorine-18 as fluoride, as nearly carrier-free as possible. *N* nitric acid is then added to give a *p*H close to 2. The mixed solution is applied to a defined area of a glass surface. (We have found good-quality microscope slides satisfactory; these are cleaned for a few seconds with dilute nitric acid followed by distilled water.) Fluoride ions are then

taken up by the glass, 80 per cent of equilibrium being reached in two or three minutes. After an adequate time, the active solution is washed off for 1 min. in a fast stream of tap-water (*p*H about 6).

At this *p*H the adsorbed material does not leave the surface at a significant rate. The amount of fluorine-18 adsorbed can then be measured by means of a Geiger counter.

The total quantity of fluorine adsorbed from solution varies only slowly with concentration. The stable and the radioactive isotopes compete for the adsorption sites available. Consequently, the stronger the mixed solution is in stable fluorine, the less fluorine-18 activity there will be in the adsorbed layer.

The method is obviously not an absolute one and is calibrated by the use of a set of standard fluorine solutions of known strength, each containing exactly the same concentration of fluorine-18 and having the same *p*H. In Fig. 1 is shown a calibration curve obtained using 4 ml. samples and 1 cm.^{2} of glass for each sample. It has clearly the form of an adsorption isotherm. The divergence from linearity at the beginning probably indicates a trace of fluorine in the nitric acid or distilled water used. Above 100 p.p.m. there is a divergence at the other end due to etching of the glass by hydrofluoric acid which increases markedly the effective surface area of the glass. The arrows represent the count given by samples of laboratory tap water and distilled water; the 0·05 p.p.m. of fluorine indicated for the tap water is in good agreement with colorimetric measurements.

In Fig. 2 is shown a calibration curve obtained using 1 mgm. samples of the standard solutions, to each of which was added 1 mgm. of *N* nitric acid and 1 mgm. of distilled water containing cyclotron-produced fluorine-18. The strength of this was in the region of 10 μc. per ml. In this particular case the material to be investigated, and hence also the calibrating solutions, were in a standard lactic-acid lactate buffer having a *p*H of 4·6. At the higher fluoride concentration this gives the same result as pure water, but the percentage sensitivity falls away a little at the lowest concentrations. This is almost certainly due to the contamination of our original materials with traces of fluorine.

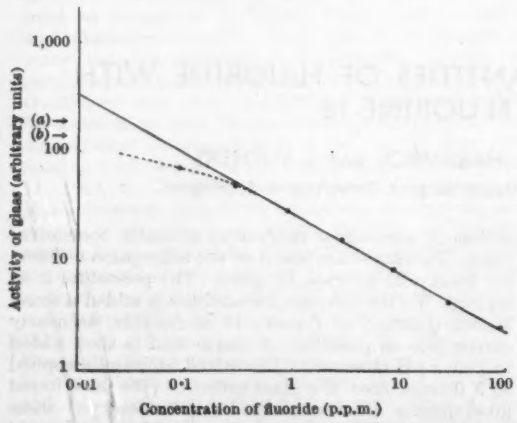

Fig. 1. (*a*) Activity of slide in distilled water; (*b*) activity of slide in tap water

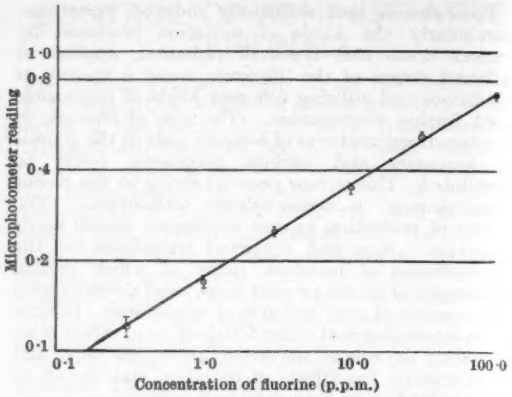

Fig. 2. Calibration curve for 1 mgm. samples in lactic acid–lactate buffer solution

In this example, a Geiger counter was not used for the measurement of the samples. Instead, all the active areas of glass (which were each about 2 mm. diameter) were placed against a single piece of X-ray film and left overnight. The developed autoradiographs were then measured by means of a microphotometer. The results of this measurement can be translated into terms of fluorine-18 activity by means of calibrated exposures to a standard source. For our purposes it is, however, convenient to plot the microphotometer readings direct.

It can be seen that at the lower concentrations an added concentration of one or two tenths of a part per million can be detected in spite of the contamination already mentioned. In one milligram of solution this corresponds to one or two ten-thousandths of a microgram of fluorine. The percentage error is fairly large, but it is not serious for our immediate purpose. Much of it is due to microphotometer errors which could be considerably reduced.

The handling of these small quantities of liquid must be done carefully to avoid evaporation. We made up several micropipettes, of about 5 per cent accuracy, of glass and 'Polythene' tubing. The latter had always been used for the acidified solutions to avoid loss of fluorine. The glass areas were defined by waxing on to the clean slide a series of 8 *BA* washers. As each sample was deposited on the slide inside the washer, a drop of liquid paraffin was placed over it, which isolated it effectively until required.

Subsidiary experiments have shown that acid, sample and radioactive solution may be added mixed or separately in any order, without any significant difference in the results, so long as the fluid mixture is left long enough to allow complete mixing (and so long as the *p*H is not raised after addition of the fluorine-18). It is evident that at a low *p*H there is a continuous rapid exchange of fluorine ions between the glass surface and the solution.

Another subsidiary experiment has shown that there is little change in take-up between a *p*H of 1 and a *p*H of 3·5, but that above 4·5 the take-up falls off very rapidly. We are investigating the effects of the presence of various other ions, but the main discovery made so far is that most materials contain a number of parts per million of fluorine and that this is quite difficult to remove.

Finally, it has been shown that, as would be expected, the variation with temperature is not large enough for a thermostat to be necessary. To give a change of 10 per cent would require a temperature difference of 4° C., which is unlikely to occur between different parts of the same microscope slide.

The principle used in this method should be applicable to many other elements and, we believe, may be of enough general interest to justify this preliminary report, although it may be some time before the results of our main research are complete.

When radioisotopes of high specific activity are obtainable, the ultimate sensitivity has been by no means reached. The limiting difficulties are probably the handling of very small quantities of liquids rather than the determination of concentration.

We would like to express our gratitude to Mrs. June Mathieson for her help with the later and more exacting stages of this work.

PHOSPHODIESTERASE FROM RATTLE-SNAKE VENOM

IN a recent communication, Boman and Kaletta[1] concluded that venom of *Crotalus adamanteus* contained two phosphodiesterases, both of which digested deoxyribonucleic acid. The evidence consisted of chromatography of venom on diethylaminoethyl-cellulose[2], resulting in two active peaks containing phosphodiesterase and deoxyribonuclease in an almost constant ratio. The ratio remained constant after about 20 per cent of each activity was destroyed by exposure to elevated temperatures. The conclusion of Boman and Kaletta[1] was not in agreement with that of Privat de Garilhe and Laskowski[3], who claimed that phosphodiesterase can be separated from deoxyribonuclease.

Phosphodiesterase was determined by the same method[3] in both laboratories, but deoxyribonuclease was determined in Upsala by the liberation of material showing absorption (E_{260}) after precipitation of the non-digested deoxyribonucleic acid with lanthanum salt in acid solution, whereas in Milwaukee it was determined viscosimetrically[4]. Clearly, viscosity will be strongly influenced if a diester bond, located in the middle of the molecule of deoxyribonucleic acid, is split, but only a little change in viscosity will be expected if a terminal mononucleotide is cleaved off. On the contrary, a cleavage occurring in the middle of the chain will produce no 'lanthanum-soluble' material; but if the terminal mononucleotide is split, it will become soluble. The two methods, therefore, do not measure the same phenomenon.

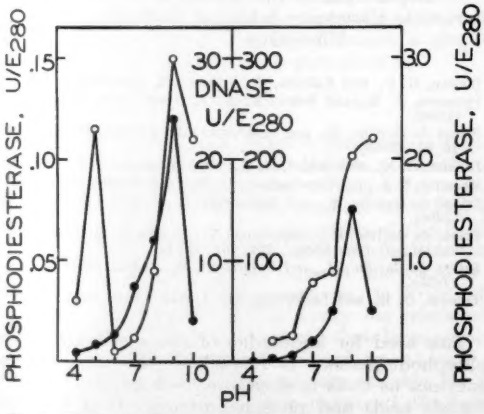

Fig. 1. Effect of *p*H on activity. Left side, crude venom; right side, preparation of phosphodiesterase purified by chromatography on diethylaminoethyl-cellulose and carboxymethyl-cellulose. Left and right ordinates represent phosphodiesterase activity (●—●) expressed in units (ref. 3) E_{260}. Central ordinates represent deoxyribonuclease activity (○—○) measured by viscosimetric method and expressed in units (ref. 4) E_{260}

Table 1. SEPARATION OF PHOSPHODIESTERASE FROM DEOXYRIBONUCLEASE

	Phosphodiesterase* U/E_{260}	Deoxyribonuclease† U/E_{260}	Ratio $\times 10^3$
Crude venom	0·08	10	8
Ppt. after dialysis, *p*H 5·5, 0·05 *M* acetate	0·008	5·2	1·5
Ppt. after a second dialysis of the previous	<0·00008	2·7	<0·3
Tube 5, chromatography of venom on diethylaminoethyl-cellulose, *p*H 8·9, 0·05 *M* *tris* buffer	4·3	70	60
Tube 32, chromatography of venom on diethylaminoethyl-cellulose, *p*H 7·5, 0·05 *M* *tris* buffer	2·9	16·2	180

* Expressed in units as defined in ref. 3.

† Measured at *p*H 8·9, *tris* buffer, expressed in units as defined in ref. 4.

The following results may be quoted in support of the contention that, besides phosphodiesterase, venom contains one (or more) deoxyribonuclease(s). Fig. 1 indicates that crude venom has two pronounced optima for the action of deoxyribonuclease (viscosity), but one for phosphodiesterase. The existence of an optimum at *p*H 5 was previously observed by Haessler and Cunningham[4]. With a partially purified preparation of phosphodiesterase, the optimum at *p*H 5 practically disappears. The optimum on the alkaline side is broader for deoxyribonuclease than for phosphodiesterase; the difference is particularly pronounced with a purified preparation. Even when both activities are measured at *p*H 8·9, they do not parallel each other during the fractionation procedure (Table 1).

This confirmation of our previous claim does not, however, contradict those results of Boman and Kaletta[1] which relate to the appearance of 'lanthanum-soluble' material as a result of the action of phosphodiesterase. On the basis of our previous work[5,7] on the action of phosphodiesterase on different fragments of deoxyribonucleic acid, it was postulated[5] that phosphodiesterase is an exonuclease and that it acts by a consecutive splitting of the 5′-terminal mononucleotide from the chain, regardless of the length of chain. The only fact difficult to reconcile with this view was our own observation[3] that an 'intact' deoxyribonucleic acid was resistant to purified phosphodiesterase. The negative conclusion drawn from this experiment is now retracted.

The following results provide additional evidence favouring the exonuclease mechanism. In agreement with Boman and Kaletta[1], phosphodiesterase obtained by chromatography of venom on '*IRC* 50' [2], carb-

oxymethyl-cellulose[8], or on diethylaminoethyl-cellulose[1], was active on both calcium [*bis* (*p*-nitrophenyl) phosphate], and deoxyribonucleic acid, when tested by the 'lanthanum-soluble' method.

In agreement with the postulation[6], the high viscosity of the digestion mixture persisted (at least until 10 per cent of the deoxyribonucleic acid became 'lanthanum-soluble'). The 'lanthanum-soluble' fraction was composed almost entirely of mononucleotides, the sum of which accounted for about 90 per cent of the optical density of the whole fraction. Fig. 2 illustrates the results of one of these experiments. Small amounts of nucleosides (peak 1) resulted from traces of contaminating 5′-nucleotidase. Peaks 6 and 7 contained some fragments higher than mononucleotides; however, they were heavily contaminated (more than 80 per cent) with the material extracted from the resin itself, since they had abnormal spectra without maxima between 250 and 290 mμ. After the pooled peaks 6 and 7 were hydrolysed with formic acid, all four bases were identified, but the total absorption (E_{260}) of the recovered bases accounted for less than 20 per cent of the value prior to hydrolysis. It was concluded that the small amounts of unidentified oligonucleotides (peaks 6, 7) were formed as a result of action of contaminating deoxyribonuclease.

The contention that the 'lanthanum-soluble' method of Boman and Kaletta[1] reflects the activities of both phosphodiesterase and deoxyribonuclease is further strengthened by the results shown in Fig. 3. The most plausible explanation is that a slow reaction, representing the consecutive cleavage of mononucleotides from the already existing terminal, changes into a rapid one, after additional terminals have been produced as a result of the action of deoxyribonuclease.

Finally, when deoxyribonucleic acid was incubated with a crude venom at *p*H 5·0, viscosity decreased fairly rapidly. However, the majority of the digest was composed of large oligonucleotides requiring[8] for elution buffers stronger than 1 *M*. The sum of nucleosides and mononucleotides accounted for less than 10 per cent; there were virtually no dinucleotides. It is interesting that a small amount of thymidine 3′,5′-diphosphate was identified among the products. Such a compound could not have been formed in a detectable quantity from deoxyribonucleic acid by the action of phosphodiesterase alone. The appearance of such a compound, however, would be expected as a result of a combined action of deoxyribonuclease (with a specificity of the deoxyribonuclease II) and phosphodiesterase[7,9].

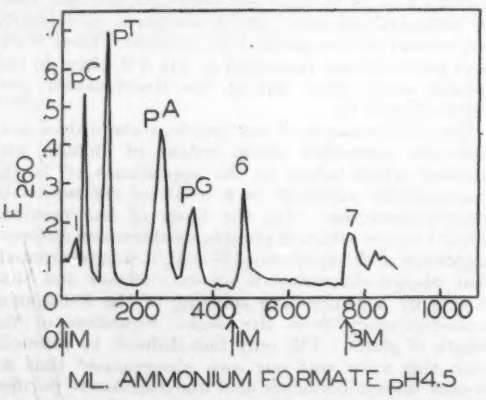

Fig. 2. Digest of 10 mgm. of deoxyribonucleic acid with 0·04 unit of purified phosphodiesterase (ref. 3), 0·05 *M tris* buffer, *p*H 8·9, 37°, 24 hr. Non-digested deoxyribonucleic acid removed with 'acid-lanthanum', lanthanum removed with oxalate. Column: 'Dowex 1-2X', 1 cm. × 10 cm. Peaks 2–5 are labelled *pC*, *pT*, *pA*, *pG*, respectively, and represent mononucleotides which were identified by the position, spectrum, ionophoresis and chromatography on paper. Peaks 6 and 7 contain some unidentified oligonucleotides and a heavy contaminant from the resin

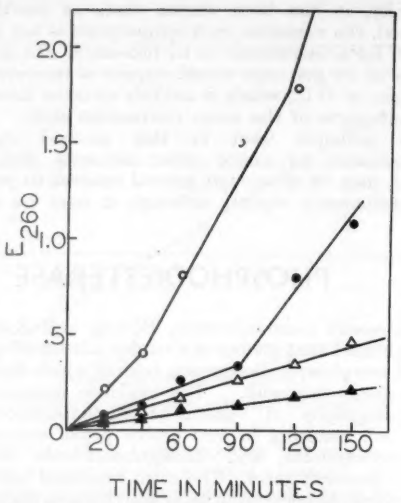

Fig. 3. Activity by the 'lanthanum-soluble' method plotted versus time. Open triangles, dialysed venom, with a ratio of phosphodiesterase/deoxyribonuclease (*p*H 8·9) = 8 × 10³; closed circles, preparation with a ratio 40 × 10³; open circles, preparation with a ratio 70 × 10³; closed triangles, the same as previous, diluted 1 : 5

This investigation was supported by grants from the Atomic Energy Commission and the American Cancer Society.

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The need for knowledge of the specificity of the phosphodiesterases is related to the use of these enzymes as tools in structure work on, for example, nucleic acids and phosphoproteins. It is therefore of great interest that Laskowski and co-workers have been able to verify our earlier conclusion that the phosphodiesterases from *Crotalus adamanteus* hydrolyse macromolecular deoxyribonucleic acid[1]. It appears also very likely that the differences in the

'deoxyribonuclease activity' obtained by the viscosimetric[2] and the 'lanthanum-acid-soluble' methods[1] are due to the fact that the phosphodiesterase has an exonucleotidase activity.

It is a separate problem if the venom, in addition to the phosphodiesterases, contains another enzyme which can decrease the viscosity of deoxyribonucleic acid (a 'deoxyribonucleic acid depolymerase') but would not act on calcium(*bis*(*p*-nitrophenyl)phosphate)$_2$. We have, at this Institute, at present no definite opinion whether or not such an enzyme exists in our batches of venom. This uncertainty is due to the following difficulties we have had in obtaining conclusive experimental results: (1) the commercially available rattle-snake venom does not appear to be a reproducible and well-defined product, probably depending on an enzymic autodigestion occurring during the collection of the venom: (2) the optimum metal-ion concentration for the enzymes does not seem to be known for the different substrates; (3) inhibition of the phosphodiesterase by small amounts of inorganic phosphate; (4) the differences in the salt concentration of the enzyme fractions from a chromatographic experiment[3], a factor which is of some relevance for activity determinations by the viscosimetric method[2].

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LIQUID-CRYSTALLINE STRUCTURES IN POLYPEPTIDES

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IN a previous communication[1], a liquid crystalline structure which occurs in solutions of certain polypeptides (for example, poly-γ-benzyl-L-glutamate) has been described. This structure is characterized by the presence of a helical twist of very large and uniform pitch which gives rise to equidistant lines (3–100μ apart, depending on the solvent and concentration) which are visible if the structure is observed at right angles to the axis of the macrohelix and to a very high form-optical rotatory power for light travelling parallel to this axis. (This form-optical rotatory power which arises from the helical nature of the multimolecular structure is distinct from, and greater by several powers of ten than, the form-optical rotatory power arising from the α-helical configurations[2,3] of the individual molecules.) These and other properties of the solutions are also found in so-called cholesteric liquid crystals[4] which are formed chiefly by esters and ethers of cholesterol, although the latter are one-component rather than two-component systems. De Vries[5] has deduced a theoretical expression for the optical rotatory power of cholesteric liquid crystals, of which a simplified form in terms of observable quantities is

$$\theta = -\frac{n^2 P}{\lambda^2} \times 4{\cdot}5 \times 10^4 \qquad (1)$$

where θ is the optical rotation observed parallel to the axis of the macrohelix in degrees per millimetre, n is the birefringence of what we may refer to as the untwisted medium, λ is the vacuum wave-length of light in microns, and P is the pitch of the helix in microns. The negative sign indicates that the optical rotation is in the opposite sense to the twist of the helix. No data were available to de Vries which would have allowed him to verify his relationship, but the polypeptide solutions with their large spacings, which can conveniently be varied by altering the concentrations or the solvent, are suitable for providing such data. We have measured the optical rotatory power at various wave-lengths for fourteen different solutions, covering a range both of concentration and solvents. In all cases the proportionality to λ^{-2} was found to hold over the visible spectrum. The pitch of the helix, which is equal to twice the microscopic spacing, could also be measured, but unfortunately difficulties were found in measuring the birefringence and only its order of magnitude was determined. However, by assuming the equation to hold, the birefringence of the untwisted medium could be calculated. In all but one of the fourteen cases the calculated value divided by the volume fraction concentration was found to fall within ± 20 per cent of a mean value of 0·0248, although the specific rotation, $[\alpha]_{4461}$, varied from 20,000° to 140,000° and the microscopic spacing from 5 to 100μ. These results suggested that the equation probably held, at least as a first approximation.

In deriving the simple form of the relationship certain approximations were made by de Vries, but we have shown by comparing numerical values of θ obtained from equation 1 with values obtained from de Vries's exact expression that the error introduced is substantially less than 4 per cent for all our experimental values of n, P and λ, and is less than 1 per cent in most cases.

Stronger evidence for the validity of the equation has been obtained in a different way. A solution was made up which contained equal quantities of the L and D enantiomorphs of poly-γ-benzyl glutamate in dioxan. This solution, instead of showing the visible periodicities and other characteristics of the helical structure, behaves as a typical nematic liquid–crystalline system. After such a solution has been allowed to flow into a suitable flat cell, a number of discrete regions develop, each of which extends throughout the thickness of the cell and in each of which the orientation is uniform. The major refractive index of each of the regions is found to lie parallel or nearly parallel to the glass, although its orientation in the plane of the glass varies from region to region, but the birefringence has a constant value for all the areas. Even more remarkable is the behaviour of this solution in the 1-mm. glass capillary. Although the solution is birefringent, shortly after filling the capillary no regular orientation can be observed with the polarization microscope, but after a short time orientation appears near the walls of the capillary

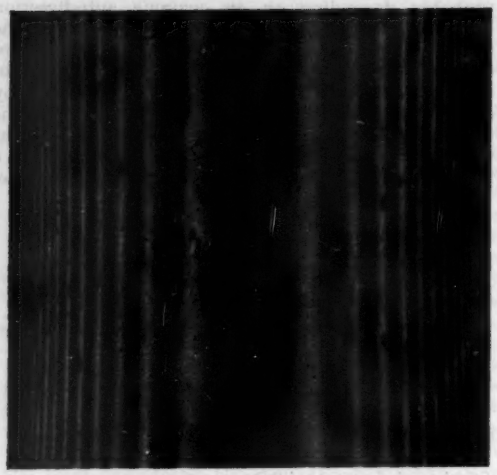

Fig. 1. The single liquid crystal of the racemic mixture of D and L polymers seen between crossed polarizers (diameter of capillary, 1·05 mm.)

and spreads gradually towards the centre. Eventually a very regular orientation is reached, as is shown in Fig. 1, which was taken in monochromatic light (λ = 5461 A.). The retardation increased continuously from the circumference of the tube to the centre. The birefringence corresponding to each fringe (assumed constant along the light path) was calculated and was found to be independent of which fringe was selected. The magnitude and sign of the infra-red dichroism (which was measured by Dr. B. R. Malcolm, of this Laboratory, using the band at 4,850 cm.$^{-1}$) is in accordance with the molecules having a high degree of orientation and lying with their long axes parallel to the length of the capillary. It would seem as if the contents of the capillary were arranged to form a single uni-axial liquid-crystal. The observed birefringence divided by the concentration was 0·029 $\pm$ 0·0015, while that in the discrete areas in the flat cell was 0·026. This compares with a value of 0·025 which was calculated from the optical rotation and helical pitch of a solution of the D enantiomorph of the same polypeptide concentration. This good agreement (the experimental error was perhaps as large as 10 per cent) leaves little doubt of the validity of the de Vries equation, and further indicates that the nematic structure in the solution containing equal quantities of both enantiomorphs may be looked upon as the untwisted counterpart of the helical structure which arises in solutions of the single enantiomorphs.

The verification of the approximate de Vries equation for the polypeptide solution in this way not only strengthens our belief in the correctness of the model of the structure that was previously put forward[1], but also provides for the first time quantitative evidence for the correctness of the conception that cholesteric liquid crystals constitute a special twisted case of nematic liquid crystals which arises when the molecules have the left- or right-handedness which is indicated by their optical activity.

The molecules of both the L and the D enantiomorphs of poly-γ-benzyl glutamate are in the α-helical configuration, the intramolecular hydrogen bonding of which gives them considerable rigidity. This rigidity no doubt is an important factor in allowing the liquid crystalline properties, whether 'cholesteric' or nematic, to persist over a considerable range of dilution.

Our thanks are due to Mr. W. E. Hanby for synthesizing the polypeptides used in this investigation.

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STRUCTURE OF GRAPHITES

Interlayer Spacings of Graphitic Carbons

BASED upon the X-ray diffraction studies of Nelson and Riley[1] on Ceylon natural graphite, Franklin[2] assigned an interlayer spacing of 3·3538 A. (15° C.) to a carbon of 100 per cent graphite structure. Any carbon having a spacing of greater than this value is said to contain less than 100 per cent graphite structure—the amount less being given by the Franklin relationship[2]. We have looked at many graphitized carbons heat treated between 2,500 and 3,000° C. which have been produced from petroleum coke and coal-tar pitch coke materials. The lowest interlayer spacing found is 3·3569 $\pm$ 0·0004 A. (15° C.), indicating, according to the Franklin correlation, that the best artificial 'graphite' obtainable under usual graphitization conditions contains about 10 per cent turbostratic structure[3].

In this work, four commercial graphitized carbons have been further heated in argon in the vicinity of 3,600° C. under a pressure of 10 atm. to investigate the possibility of lowering the interlayer spacing of the carbon down to or below that of Ceylon natural graphite. The above pressure prevented any significant sublimation of the carbon. The X-ray procedures used have been thoroughly described in a previous publication[4].

Table 1 presents the X-ray diffraction data and other pertinent information on the samples. The interlayer spacing for the Ceylon graphite used is in close agreement with the value found by Nelson and Riley, particularly considering the probability that the two samples were not exposed to precisely similar geological conditions. The change in interlayer spacing of the carbons upon heat treatment is seen to be in qualitative agreement with the amount of impurities evolved. It is of further interest to note the parallel between the decrease in interlayer spacing and the irreversible change in thermal expansion above 2,200° C. during the first heating.

Even though increasing the graphitization temperatures of the carbons to 3,600° C. did produce some additional decrease in interlayer spacing, the lowest spacing obtainable still is indicative of a carbon containing only 90 per cent graphite structure. It is

Table 1. Interlayer Spacings of Carbons

Sample	*d*-Spacing (A.) (15° C.)	Relative amount of impurities evolved on heat treatment*	Per cent irreversible decrease in thermal expansion above 2,200° C. during first heating†
Ceylon natural graphite	3·3544 ± 0·0001		
Type *A*,			
< 3,000° C.	3·3623 ± 0·0004	Moderate	0·05
3,600	3·3604 ± 0·0001		
Type *B*,			
< 3,000° C.	3·3584 ± 0·0004	Moderate‡	0·03
3,600	3·3569 ± 0·0001		
Type 1,			
< 3,000° C.	3·3586 ± 0·0001	Negligible	0·00
3,600	3·3585 ± 0·0003		
Type 2,			
< 3,000° C.	3·3660 ± 0·0003	Large	0·25
3,600	3·3584 ± 0·0003		

* The impurities consisted of lacy, white material appearing in the cooler regions of the furnace.
† The irreversible effects were only noticed in the direction normal to the extrusion axis or parallel to the moulding axis, that is, along the preferred *c*-axis orientation in both cases.
‡ There was somewhat less impurity for sample *B* than for *A*.

felt that the higher interlayer spacing values found for the artificial 'graphites' in comparison with that for Ceylon graphite is a result of the inability of the crystallites to grow as large in artificial 'graphites'. As Bacon[5] and Pinnick[6] have discussed, the interlayer spacing decreases as crystallite diameter increases. This variation in interlayer spacing is due to the competition between the aligning forces between planes and the 'pinning' forces at their edges, the competition being a function of crystallite size. It is thought that the factor restricting crystallite growth in the graphitized carbons is the porosity developed previously during the coking cycle. These pores within the coke particles act as boundaries across which crystallite growth cannot occur. In comparison with this, Ceylon natural graphite particles are dense and non-porous, crystallite growth not having been restricted. Coking under a high static pressure would probably produce a better-ordered, lower porosity material, which upon subsequent graphitization would yield a carbon with an interlayer spacing more closely approaching that of Ceylon natural graphite.

We thank the Atomic Energy Commission, Contract No. *AT*(30–1)—1710, for support, in part, of this work. We express particular appreciation to N. S. Rasor, of Atomics International, for heat-treating the samples, supplying the data on impurity release and thermal expansion, and offering many constructive criticisms on the manuscript.

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Graphitic Character of Kish

Kish is a waste product which forms on the surface of molten iron of high carbon content during the manufacture of steel. It is carbon which has been taken into solid solution with the iron and is afterwards evolved when the iron cools. Kish particles are shiny and flaky, resembling large particles of natural graphite. It is of interest to compare the graphitic character of kish with Ceylon natural graphite by interlayer spacing measurements. X-ray procedures used have been thoroughly described in a previous publication[1].

Table 1. Interlayer Spacings of Kish and Ceylon Natural Graphite before and after Various Treatments

Sample	Treatment	*d*-Spacing (A.) (15° C.)	Ash content (per cent)
Kish	None	3·3528 ± 0·0002	48·4*
Kish	HCl	3·3544 ± 0·0001	23·2
Kish	HCl + HF	3·3540 ± 0·0001	2·9
Kish	2,800° C.	3·3543 ± 0·0003	0·6
Ceylon natural graphite	None	3·3543 ± 0·0001	2·1
Ceylon natural graphite	2,800° C.	3·3543 ± 0·0001	0·0

* The main constituents were iron and silicon.

Table 1 presents interlayer spacing data for kish and Ceylon natural graphite before and after various treatments. It is noted that the raw kish has an interlayer spacing significantly less than that of the Ceylon natural graphite. However, after acid treatment or graphitization at 2,800° C. the spacing is found to increase to the same value as Ceylon natural graphite.

The increase in interlayer spacing upon purification suggests that the carbon in the raw kish is subjected to considerable internal pressure because of the contraction of the molten iron. Assuming a volume compressibility of $4{\cdot}4 \times 10^{-6}$ cm.²/kgm. for carbon[2], an internal pressure of *ca.* 100 kgm./cm.² is calculated for this particular kish sample. It is significant that acid treatment with only hydrochloric acid, which would remove the iron but not the silicon, increases the interlayer spacing to the Ceylon natural graphite value. This suggests that iron alone is subjecting the carbon to the high internal pressure.

It is suggested[3] that Ceylon natural graphite was crystallized from an iron melt in the same manner as kish. However, in the case of Ceylon graphite, it is not clear what happened to the iron which had to be originally present to produce the high internal pressure. Thus it is seen in the present work, since the interlayer spacing of Ceylon graphite does not change after graphitization, that the carbon (after mining) is not under an internal pressure. In the formation of Ceylon graphite, it would seem that the pressure necessary to produce good ordering and consequent large growth of the carbon crystallites, with an attendant small interlayer spacing, could be produced by the depth of the deposit. Assuming a density of 3·0 gm./c.c. for the Earth, a material at a depth of *ca.* 330 m. would be under a pressure of 100 kgm./cm.².

We thank the Atomic Energy Commission, Contract No. *AT*(30–1)—1710, for support, in part, of the above work.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Geomagnetic Field in Upper Triassic Times in the United States

It is commonly assumed[1] that magnetically stable rocks have a remanent magnetization in the direction of the geomagnetic field at the time of formation, and that the mean direction determined from samples collected through a considerable thickness of one rock formation is that of a dipole field orientated along the axis of rotation of the Earth at that time.

Because of the possibility of special effects, such as magnetostriction, the view has been taken[2] that these assumptions are likely to be in error and that in consequence the inferences which have recently been drawn from palæomagnetic studies[1] concerning the occurrence of polar wandering and continental drift in the geological past are based on no substantial grounds. A test relevant to this discussion is to determine whether rocks of the same age within one continent give pole positions in agreement, although it must be remembered that the geological age of those rocks which are most strongly magnetized, lavas and red sandstones, cannot usually be established with precision because diagnostic fossils are often scarce or lacking.

Measurements on rocks of Upper Triassic age collected in the United States have recently been made in Newcastle, Cambridge and Canberra, as shown in Table 1. In all cases the number of samples was small but they were well spread stratigraphically. The Springdale Sandstone[3] was collected from Zion National Park, Utah, and those from the eastern United States from the lower Connecticut Valley, from the upper Connecticut Valley and from New Jersey. The pole positions calculated on the assumption of an average dipole field are given in Table 1 and are plotted in Fig. 1. The ovals of confidence of the pole positions overlap.

The pole based on measurements of the Upper Triassic Keuper Marls of England[4] and its oval of confidence is also given for comparison—it is believed that this discrepancy results from post-Triassic continental drift.

From these results three points of interest arise.

(1) They show that results from small numbers of samples can be quite reliable and provide a practical demonstration of the validity of the sampling methods advocated by Irving and Watson[5] and by Runcorn[6].

(2) Results from both igneous and sedimentary rocks laid down at approximately the same geological time but at points thousands of miles apart within the same continent are in agreement, and indicate the high degree of certainty with which these 'fossil' directions may be identified with the Earth's magnetic field during the Upper Triassic so that in these red sandstones and lavas it seems that the special effects mentioned above are of negligible importance.

(3) It seems reasonably certain that during this time the geomagnetic field over the region of the United States approximated on average to that of a dipole as it is known to have done since the Miocene[7,8].

Table 1

Formation	No. of determinations	Mean direction			Sampling area		Pole position			
		D	*I*	α	Lat.	Long.	Lat.	Long.	$d\chi$	$d\psi$
1. Springdale Sandstone	18 disks from 8 samples	338	+16	—	37 N.	113 W.	55 N.	107 E.	—	—
2. Lavas near Holyoke, Mass.	8 samples from 3 flows	10	+14	11°	42 N.	73 W.	54 N.	90 E.	11	6
3. Lavas and sediments of Connecticut	12	12	+14	15°	42 N.	73 W.	55 N.	88 E.	15	8
4. New Jersey (Brunswickian formation of Newark series)	71 disks from 21 samples	6	+28	3°	41 N.	75 W.	63 N.	93 E.	6	3

Mean directions of magnetization of Upper Triassic formations from the United States, specified by declination *D* reckoned eastwards from geographical north and the inclination *I* positive downwards. α is the angle of confidence at the 95 per cent probability-level. The semi-axes of the ovals of confidence of the poles, $d\psi$ and $d\chi$, in the direction of and perpendicular to the great circle joining the pole and the site are given. The significance of α, $d\psi$ and $d\chi$ have been discussed previously (ref. 1).

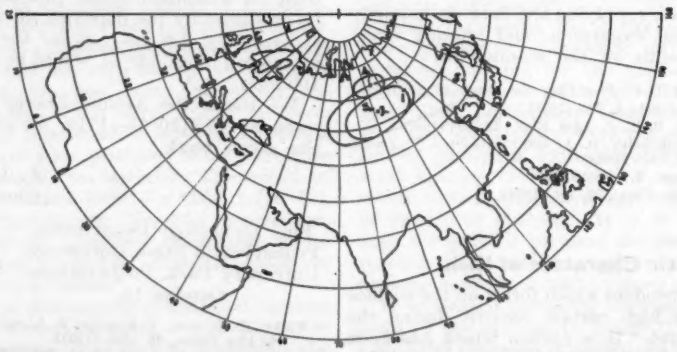

Fig. 1. Position of the geomagnetic pole in Upper Triassic times relative to the United States and Europe. The determinations from rock formation in the United States are numbered as in Table 1. The equivalent pole determined from England is numbered 5

The axis of this dipole intersected the Earth's surface in the regions of what are now central Siberia and southern South America.

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Charged Particles in a Non-uniform Radio-frequency Field

An analysis of the motion of a charged particle in a non-uniform radio-frequency field has been made and has shown that under certain conditions particles of either sign will experience an acceleration towards the position of least electric field strength.

Considering the Lorentz forces upon free electrons, a second-order force arises due to spatial variation of the electric field-strength, which is of the same order as the conventional forces due to motion in the magnetic field and charge density fluctuations. In a continuous but not necessarily homogeneous electron distribution, such as we suppose to exist in a collision-free and neutral plasma, a small-signal theory shows that the time-averaged force per unit volume upon the electrons is, $f = -\frac{1}{2}(\rho e/\omega^2 m)\nabla(\overline{E \cdot E})$, where ρ is the average electron charge density, $\omega = 2\pi \times$ frequency, $\overline{E \cdot E}$ is time-averaged square of electric field, in rationalized M.K.S. units.

The total force upon an isolated body of electrons is the same as that given by conventional theory[1] from the field equations; the force is therefore consistent with the concept of radiation pressure. The internal stresses, or pressure in a fluid, differ, however, from the conventional theory, and appear to enhance the possibility of containing a heated plasma within a resonant cavity by radiation pressure[2].

It is hoped that it will shortly be possible to publish the details of the calculations which we have quoted.

The existence of such a force on electrons has been demonstrated in a 10-cm. slotted anode magnetron having no magnetic field and a cold cathode. Pulses of 10-cm. radio-frequency power were fed into this magnetron and set up electromagnetic fields which decreased towards the cathode. The multipactor effect produced a copious supply of electrons within the slots and limited the radio-frequency voltage there to about 5 kV.

Pulses of electrons arrived at the cathode with energies up to 250 volts, and current of up to 0·1 amp. per cm. length of cathode could be drawn with anode and cathode at the same potential. The anode and cathode diameters were 1·25 and 0·59 in. respectively. A small increase in cathode temperature was observed with a thermocouple, which proves that the current was due to negative particles bombarding the cathode.

Acknowledgment is made to the Admiralty for permission to publish this communication.

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Some Observations of the Infra-red Solar Spectrum from a High-flying Aircraft

The strong absorption bands of water vapour and carbon dioxide in the infra-red obscure much of the solar spectrum from observation on the ground. By working at high altitude, however, it is possible to use measurements of absorption in these bands for obtaining data about the concentration of water vapour and other atmospheric constituents in the upper atmosphere. To make such measurements, an infra-red grating spectrometer with a resolution ~ 2 cm.$^{-1}$ has been installed in a Canberra aircraft. A heliostat maintains a steady image of the sun on the input slit of the spectrometer. The spectrometer and heliostat are installed in the unpressurized part of the aircraft necessitating an elaborate system of remote control for its operation.

Successful ascents have been made in which the spectral region 1·8–2·1μ has been observed using a

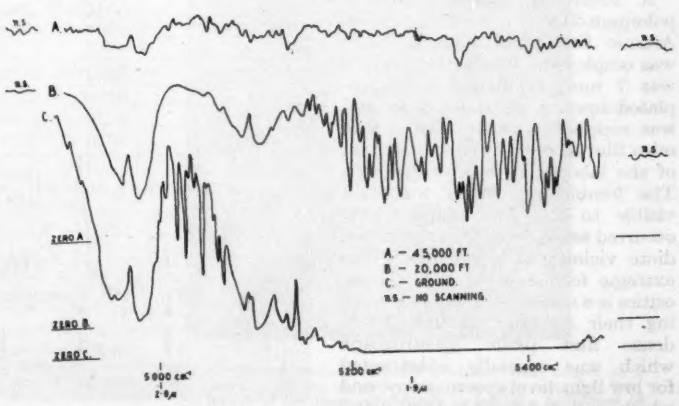

Fig. 1. Solar spectra

lead-sulphide detector. The absorption in this region at different heights is shown in Fig. 1. The good performance of the heliostat is demonstrated by the steadiness of the trace at each end of the spectral region where the spectrometer is not scanning. The 1·9μ water vapour absorption band and the 2μ absorption bands of carbon dioxide are clearly shown. It is clear that the water-vapour absorption is rapidly disappearing at the higher altitudes. A path-length of laboratory air containing only 7 microns of precipitable water vapour would give the same absorption as that shown on the record at 45,000 ft. Since this trace was taken at a solar elevation of 47°, the amount of water vapour in a vertical column of atmosphere above 45,000 ft. would be equivalent to a path of laboratory air containing approximately 5 microns of precipitable water. This is the first time an estimate of this important meteorological parameter has been made.

More extensive measurements over the spectral region 1–8μ are planned for the future.

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Luminescence produced in Air by Polonium-210 α-Particles

A knowledge of the spectral composition of the feeble luminosity arising from the passage of energetic ions through gases is essential to the complete understanding of the processes by which the ions lose energy along their tracks. It also has important applications to the physics of the aurora (part of which is excited by traversal through the high atmosphere of solar protons), and in the efficient use of gas scintillators in nuclear physics.

Following studies of the luminosities produced by 2–4 keV. lithium ions in atmospheric gases[1] (which have recently been extended) the present communication deals with observations upon the luminosity maintained in air at atmospheric pressure by high-energy (5·3 MeV.) α-particles.

A 28-mc. α-particle source of polonium-210 (obtained from Atomic Energy of Canada, Ltd.) was employed. The active surface was 7 mm. in diameter, electroplated upon a platinum disk, and was supplied covered with a thin mica film to prevent contamination of the laboratory by recoil nuclei. The luminosity, which was just visible to the dark-adapted eye, occurred as expected[2,3] in the immediate vicinity of the source. The extreme feebleness of such luminosities is a major difficulty in recording their spectra. A fast (f/1·1) dense flint prism spectrograph which was specially constructed for low light-level spectroscopy, and which will be described in detail elsewhere, was used in this experiment. It incorporated a 35-mm. camera with a 9-element f/1·1 lens of 5 cm. diam. This instrument recorded the wave-length range of 3800–8000 A. on about 8 mm. of film.

The polonium source was mounted directly in front of the slit and almost perpendicular to its plane so that the luminosity at the surface of the disk was viewed at a very acute angle to the surface by the spectrograph. A front-surfaced mirror was placed on the side of the source remote from the spectrograph to increase the amount of light gathered by it. Alignment of source and mirror was attained by autocollimation. The whole experiment was performed in a darkened room the temperature of which was maintained at 72° F. to minimize thermal exposure of the infra-red sensitive emulsion employed. Kodak *HIR* 402 (identical emulsion to 1-*N*) 35 mm. film was used in the camera, and an exposure of ten days was adequate.

A typical spectrum, together with microphotometer trace, is shown in Fig. 1. All observed features lie between 3800 A. and 4800 A. The detailed identifications are made in Table 1 and the wavelengths are certainly reliable to ± 2 A. The spectral features are entirely bands of the N_2 second positive and N_2^+ first negative systems. The N_2^+ bands appear to have approximately the same relative intensities as when excited in gas discharges through He–N_2 mixtures[4], while the intensity distribution of the N_2 bands indicate enhancement of the 0 and 1 levels of the $C^3\Pi$ state over the conditions of simple discharge through N_2. No atomic lines of NI, NII, OI, OII, HeI or HeII, nor molecular bands of O_2 or O_2^+, were observed over the wavelength range 3800–4800 A. NI and OI lines, if present, would have been registered by the most sensitive range of the emulsion (~ 7000 A.).

These results are entirely consistent with those of Sir William and Lady Huggins[5], who used α-particles from radium to excite air, and made observations over the wave-length range 2600–4300 A. The identifications of Ortner and Salim[6] are, however, not confirmed. They used a 4-mc. source of polonium

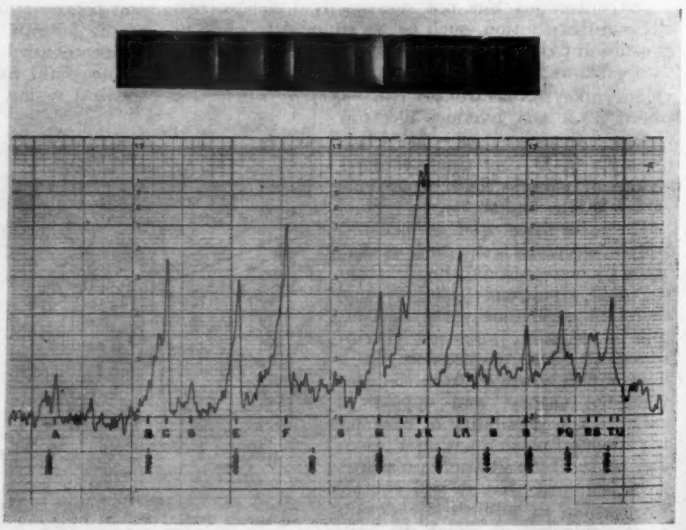

Fig. 1. Spectrum and microphotometer tracing of luminosity produced by α-particles in air

Table 1. Identification of Spectral Features of Fig. 1

Feature	Wave-length (A.)	Identification	Comments
A	3805	(0,2) N_2	
B	3895	(3,6) N_2	very weak
C	3914	(0,0) N_2^+	
D	3943	(2,5) N_2	
E	3998	(1,4) N_2	
F	4060	(0,3) N_2	
G	4140, 4142	(4,5) N_2^+, (3,7) N_2	N_2^+ probably weak
H	4199, 4200	(2,3) N_2^+, (2,6) N_2	
I	4236	(1,2) N_2^+	
J	4270	(1,5) N_2	
K	4278	(0,1) N_2^+	
L	4343	(0,4) N_2	
M	4355	(4,9) N_2	very weak
N	4417	(3,8) N_2	
O	4490	(2,7) N_2, (5,7) N_2^+	N_2^+ weak
P	4574	(1,6) N_2	
Q	4600	(2,4) N_2^+	weak
R	4649, 4652	(4,10) N_2, (2,4) N_2^+	N_2 probably weak
S	4667	(0,5) N_2	
T	4709	(0,2) N_2^+	
U	4723	(3,9) N_2	weak

for exciting air under conditions very comparable to those in our experiment, and made identifications (to ± 10 A.) of OI, OII, NI, NII lines together with some 'continua', in the region 3730–6000 A. A comparison of their wave-lengths (including tolerances) with those in Table 1 indicates that some of their lines and continua may in fact have been N_2 second positive and N_2^+ first negative bands.

Ionization with excitation (1), and charge transfer with excitation (2) (3), are the most probable mechanisms responsible for the excitation of the N_2^+ bands.

That is:

$$He^{++} + N_2 \rightarrow He^{++} + N_2^{+*} + e \quad (1)$$

$$He^{++} + N_2 \rightarrow He^{+} + N_2^{+*} \quad (2)$$

$$He^{+} + N_2 \rightarrow He + N_2^{+*} \quad (3)$$

Followed by

$$N_2^{+*} \rightarrow N_2^{+} + h\nu \text{ (bands)} \quad (4)$$

It would be unlikely, however, that the N_2 bands could have been excited by α-particles in view of the multiplicity change ($X^1\Sigma \rightarrow C^3\Pi$) required which is more readily caused by electron exchange. This could possibly be brought about by the fast helium ions or even by the fast helium atoms formed in equations (2) and (3). However, in view of the intensity of the bands, it is more likely that they were excited by the energetic electrons (δ-rays) formed along the α-particle tracks. The absence of lines of NI and OI is an indication that the primary collisions between α-particles and air molecules occur too rapidly to cause dissociation[1]. The complete absence of lines of He I and He II indicates that they are probably formed in their ground states (2), (3) at the ends of their tracks, prior to which (1) they are not formed at all.

This work has been supported by contract *AF* 19(604)1718 with the Air Force Cambridge Research Centre. One of us (E. M. R.) has been supported during the course of this work by a scholarship from the Ontario Research Foundation.

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Study of the Magnetic Leakage Field in Cobalt by means of a Divergent Electron Beam

The leakage field due to the magnetic domains in an unmagnetized single crystal of hexagonal cobalt has been shown to produce various effects on an electron beam[1]. A new method for the study of this leakage field using a divergent electron beam has been developed recently. The electron beam of a conventional electron diffraction apparatus is limited as before by a small movable aperture of 6–25μ, close to the crystal. The crystal face is adjusted to an angle of glancing incidence between a fraction of a degree and a few degrees. Immediately below the aperture are fixed on to the same holder two parallel metal plates, to which an alternating potential difference is applied. A beam is thus provided which diverges from a point close to the aperture in a direction parallel to the crystal edge. This beam scans at the level of the specimen a region which is extended in a direction parallel to the crystal edge, but which is only of the width of the aperture in a direction normal to it. The electrons of this beam are deflected by the magnetic leakage field existing in this region.

Figs. 1,*a–e* show the curves obtained by this method with a beam of 46-keV. electrons passing at distances of 10, 30, 60, 90 and 160μ from the prism face. The beam forming the centre part of the trace is approximately parallel to the hexagonal axis. The undistorted trace, obtained by removing the crystal from the beam, has been taken on the same plate for each position of the aperture. Similar curves were obtained from the hexagonal face of a cobalt crystal.

The trochoid-like nature of these curves can be interpreted in terms of the deflexion of the electrons by a periodic magnetic field[1]. Depending on the ratio between the magnitude of the field and the domain spacing, three types of trochoids can be distinguished (Figs. 1,*a–b*, Fig. 1,*c* and Figs. 1,*d–e*, respectively).

The method described has been applied to the study of the variation of the magnetic leakage field

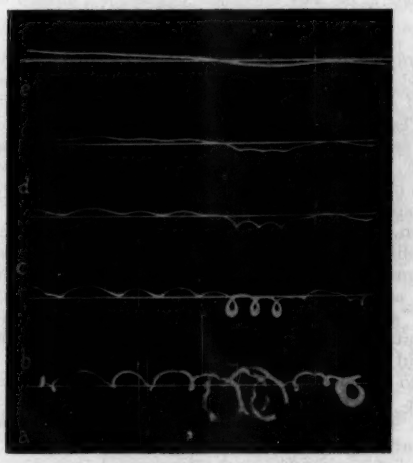

Fig. 1. Curves obtained with the divergent beam, limited by a 6μ aperture, passing at various distances from the prism face. The length of the trace corresponds to scanning a distance of 1·7 mm. along the crystal edge

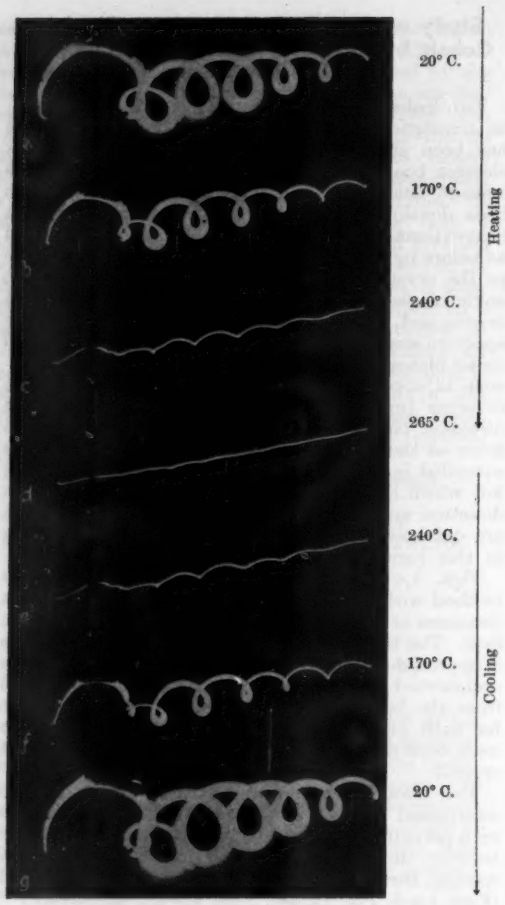

Fig. 2. Curves obtained with the divergent beam, limited by a 9μ aperture, at various temperatures. The scan is set at an angle to the edge, the left end of the beam grazing the prism face. The length of the trace corresponds to scanning a distance of 1·0 mm. along the crystal edge

with temperature. Fig. 2 shows the deflexion curves obtained at various temperatures with the divergent beam of 46-keV. electrons passing close to the prism face. The primary beam has been adjusted as before almost parallel to the hexagonal axis; the scan has, however, been arranged so that the region traversed forms a small angle with the crystal edge at the level of the specimen and grazes the edge at one end of the scan. This procedure allows a higher accuracy to be obtained in the setting. The steady decrease of the magnitude of the leakage field with temperature is apparent. It becomes very small at about 250° C. and remains so until 380° C. (the highest temperature investigated). The variation of the leakage field with temperature has been deduced. It was also observed (Fig. 2) that the domain spacings did not change with increasing temperature up to 240° C. They returned identically from 240° C. downwards after the crystal had been heated to 300° C. and cooled again. Using the hexagonal face, the decrease of the magnitude of the leakage field with temperature was similar. However, in this case changes of the domain spacings with increasing temperature were observed. Furthermore, these were not identical after the crystal had been heated to 300° C. and cooled again.

The steady decrease of the magnitude of the leakage field is in agreement with the conclusions derived from measurements of the anisotropy constants[2]. These show that at room temperature the hexagonal axis is the direction of easy magnetization and that this anisotropy decreases with increasing temperature, the crystal becoming isotropic at about 250° C. Above this temperature the hexagonal axis is the direction of most difficult magnetization. Therefore the energy required to form 'domains of closure' at right angles to the hexagonal axis, which can give rise to a continuous flux circuit inside the crystal, is expected to decrease with increasing temperature, becoming zero at about 250° C.

A detailed account of this work will be published elsewhere. One of us (E. G.) is indebted to the British Council for a scholarship and grant and to the University of Chile for leave of absence.

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Changes in the Structure of Carbon during Oxidation

It has previously been shown that, in the so-called amorphous carbons, a part of the carbon is organized in small graphite-like layers, and a part is in a form so disordered that it gives only a gas-like scattering of X-rays. Furthermore, of the graphite-like layers, some are stacked in small parallel groups with a characteristic interlayer spacing, while others are effectively single[1]. Since cokes and other commercial carbons used in processes involving combustion have structures of this type, it is clearly of interest to determine which features of the structure of the carbon most influence its combustion properties. This communication summarizes the preliminary results of such an investigation.

The influence, on structure, of various forms of controlled partial combustion was studied; the structure of the carbons was analysed, by X-ray diffraction methods previously described[1], before oxidation, and then after subsequent removal of oxygen by heating *in vacuo* at 1,000° C.

Samples of carbon containing 2–20 per cent weight of oxygen were prepared either by heating in oxygen at 300–450° C. for several days or by reacting with ozone at room-temperature and removing the oxidation products of low molecular weight by heating to 300° C. On heating the solid product under vacuum, the oxygen adsorbed was evolved as carbon monoxide and dioxide in ratios and amounts which depended only on the temperature of the desorption: at 1,000° C. very little oxygen remained.

X-ray powder-photographs of the initial carbon, the oxidized carbon, and the final degassed product were obtained, using a bent-quartz focusing mono-

Table 1. Structure of Oxidized Polyvinylidene Chloride Char

Analysis of structure	Initial carbon	Oxidized carbon		Degassed at 1,000° C.	
		Oxygen product	Ozone product	Oxygen product	Ozone product
Disordered (per cent)	35	60	59	32	35
Parallel groups (per cent)	22	40	41	36	45
Single layers (per cent)	43	0	0	32	20
M*	2·0	4·0	3·0	2·6	2·2
Interlayer spacing (A.)	3·86	3·47	3·50	3·55	3·57

* M is the mean number of layers per parallel group, and is independent of the number of isolated layers.

chromator, a continuously evacuated camera, and copper K_α and molybdenum K_α radiations. From these photographs the proportion of carbon which was organized into graphite-like layers, the proportion of such layers stacked in parallel groups and the mean number (M) of such layers per group were determined[1].

As an example, Table 1 gives the results for a char prepared by the pyrolysis of polyvinylidene chloride at 1,000° C. and oxidized both in oxygen and in ozone.

It is evident that the structural changes which result from the two methods of oxidation are very similar; the oxidized carbon is characterized in each case by a disappearance of single layers and by a marked increase in the layer stacking. A clearer picture of the significance of these results is given by recalculating the figures for the ozonized product (gm./100 gm. initial carbon) as in Table 2.

Table 2. Structure of Ozonized Polyvinylidene Chloride Char

	Disordered (gm./100 gm.)	Parallel groups (gm./100 gm.)	Single layers (gm./100 gm.)
Initial carbon	35	22	43
Ozonized product, 300° C.	34	24	0
Ozonized product, 1,000° C.	17	22	10

It may be seen from this that the most vulnerable part of the structure is that which exists as single graphitic layers: the disordered part is less vulnerable but is still more reactive than the parallel groups, the amount of which remains unchanged throughout the treatment.

The apparent increase in parallel stacking of the graphite-layers on oxidation is of general occurrence; we have observed it with carbons prepared from sucrose and cellulose as well as with commercial charcoals and carbon blacks. To a lesser degree it is noticeable also in the oxidation of carbon by nitrous oxide at 500° C. and by steam at 900° C. In each case the increase in the value of M in the oxidized carbons is accompanied by a decrease in the low-angle scattering, suggesting that the spaces between the separate particles have been filled by oxygen to produce the diffraction effect of larger particles, and by a decrease in the interlayer spacing. We have also observed an analogous effect in a series of nitrogen-containing carbons prepared by the pyrolysis of melamine-formaldehyde resin. At 500° C. a product is obtained which contains 41·5 per cent of nitrogen and has an M-value of 5·5: by heating to 1,000° C. for 4 hr. the nitrogen content is reduced to 0·4 per cent and the M-value to approximately 3·5. It is hoped that further measurements on both nitrogen- and oxygen-containing carbons will enable these effects to be interpreted more fully.

It is significant that the shape of the 110 and 100 bands remains constant throughout the oxidation process, indicating that the graphite-like layers do not change in diameter. This again indicates that the combustion process does not consist, as is sometimes suggested, of a gradual consumption of the layers, starting from the edges and proceeding inwards. It seems, rather, that there is a tendency for the layers either to remain intact or to be wholly consumed, isolated layers being particularly susceptible to total destruction.

This work was supported by the National Coal Board.

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Effect of Nitric Oxide on the Radiosensitivity of Bacteria

Oxygen is known to increase the effectiveness of X-rays in killing bacteria[1,2] and cells from many other organisms[3] by a factor of 2 or 3. There have been numerous reports of substances which protect against the effects of irradiation under aerobic conditions[4], but there does not appear to be any report of a substance which, in complete anoxia, raises the radiosensitivity of bacteria to the level normally associated with full aeration. Before giving the evidence which suggests that nitric oxide may be such a substance, we may consider the factors which first directed attention to this gas.

The observed effect of oxygen on radiosensitivity implies that ionizing radiation produces lesions in the bacteria, some of which are converted to lethal injuries only if oxygen is present. It has been postulated that such a lesion is a radical, probably on a carbon atom in one of the molecules which are essential to cell survival[5]. It may be supposed, therefore, that oxygen affects radiosensitivity by virtue of its affinity for carbon radicals. Molecular oxygen owes its reactivity and its affinity for free radicals to the unusual configuration of electron spins in the outer orbitals. Of the sixteen electrons in oxygen, fourteen fill the σ_g ($2p$) and lower energy orbitals which form the almost inert structure of molecular nitrogen. The remaining two electrons in molecular oxygen are in two π_g ($2p$) orbitals. There is spectroscopic evidence that these electrons have unpaired spins, a finding which explains the paramagnetic properties of molecular oxygen[6]. The two unpaired electrons make oxygen a biradical and give it an affinity for other radicals[7].

Another paramagnetic molecule which has an unpaired electron in the $\pi_g(2p)$ orbital is nitric oxide, the most stable molecule with an odd number of electrons. Nitric oxide is a stable gas with little

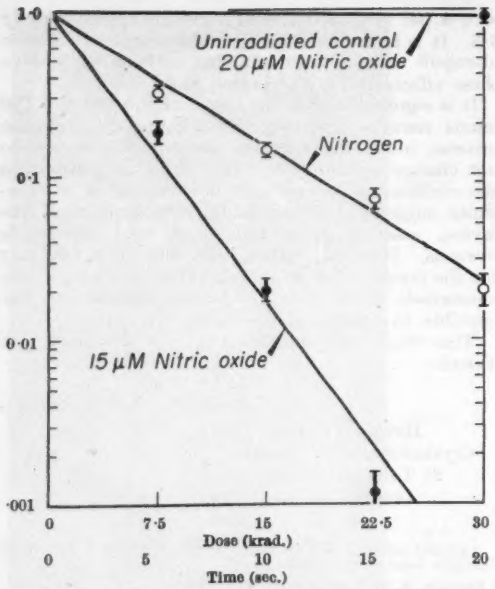

Fig. 1. Survival curves for *Shigella flexneri* irradiated with 250 kV. X-rays while the suspension was bubbled with either nitrogen or nitrogen containing 0·8 per cent nitric oxide. The upper line shows the effect of the nitric oxide mixture on the cells in the absence of any radiation

tendency to dimerize. It is more soluble than oxygen in water and it does not hydrolyse or dissociate to any great extent. Nitric oxide shows an affinity comparable to that of oxygen, for carbon radicals[7]. It combines readily with oxygen to form nitrogen peroxide, which hydrolyses in water to form nitric acid, so that nitric oxide can be used only in the absence of oxygen. Nitric oxide combines reversibly with hæmatin[8] and cytochrome oxidase[9], forming compounds similar to those of carbon monoxide. That nitric oxide is not toxic in small amounts is shown by the observation that certain bacteria form it in the course of the reduction of nitrites to nitrogen[10]. It would seem from this list of properties that nitric oxide might affect radiosensitivity in much the same way that oxygen does, while at the same time having a contrasting action on cell metabolism.

A preliminary investigation has been made into the effects of nitric oxide on the radiosensitivity of bacteria which were kept free from oxygen while in contact with the gas. The methods used follow those of a previous investigation into the effect of oxygen on radiosensitivity[2]. An overnight broth culture of *Shigella flexneri* was washed, resuspended and diluted for use in buffered saline. Samples were placed in a glass irradiation vessel with a glass filter base, through which oxygen-free nitrogen was passed. The suspension was vigorously bubbled with nitrogen for an initial period of equilibriation, as well as throughout the course of the irradiation carried out at 25° C. with 250 kV. X-rays filtered with 0·5 mm. aluminium, at a dose-rate of 1,500 rads per min. The top of the irradiation vessel was closed except for a narrow capillary outlet, through which the gas escaped. The suspension was sampled through the same capillary by tilting the vessel. The samples taken before and during the course of the irradiation were plated out on nutrient agar and incubated. The number of bacteria surviving was found from the visible colony counts. When required, nitric oxide was mixed with oxygen-free nitrogen in amount determined by a flow-meter consisting of a glass tube along which a mercury pellet was pushed by the gas. When starting an experiment, the cell suspension was bubbled with nitrogen for a period of at least 5 min. at a flow-rate of 5 ml. per sec. before admitting nitric oxide. Samples were withdrawn when required and were passed from the irradiation vessel into a vial and bubbled with nitrogen to remove the nitric oxide before there was appreciable exposure to air. In addition, control samples were bubbled with nitric oxide for a period comparable with the time of the irradiation to test the effect of the gas alone upon the survival of the bacteria.

The results are shown in Fig. 1. It was found that 0·8 per cent of nitric oxide in the gas mixture, which gave a concentration of 15 μM, was sufficient to double the sensitivity of the bacteria to radiation, while in the absence of any irradiation, exposure to nitric oxide at a concentration of 20 μM reduced the number of survivors by 10 per cent in a comparable time. The increase in sensitivity observed with nitric oxide is about the same as that observed with oxygen at a comparable concentration[2]. Further experiments will be needed to test whether oxygen and nitric oxide are comparable, molecule for molecule, in their effect upon the sensitivity of bacteria and other micro-organisms.

It is of interest that the bacteria given nitric oxide in place of oxygen should show the radiosensitivity normally associated with aerobic conditions, while all aerobic metabolism has been halted.

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Delocalization in Hydrogen Bonds

It is well known[1,2] that the proton magnetic resonance 'chemical shift' of the hydroxyl peak in solutions of alcohols depends on concentration, as a result of changes in the extent of hydrogen bonding.

We have now shown that polymeric species contribute much more towards the shift to low field which occurs under conditions favouring hydrogen bonding than does the hydrogen-bonded dimer. This has been verified (*a*) by correlation of the chemical shifts with infra-red data on simple alcohols (from which taking account of the different extinction coefficient of monomer, dimer, and polymer, a

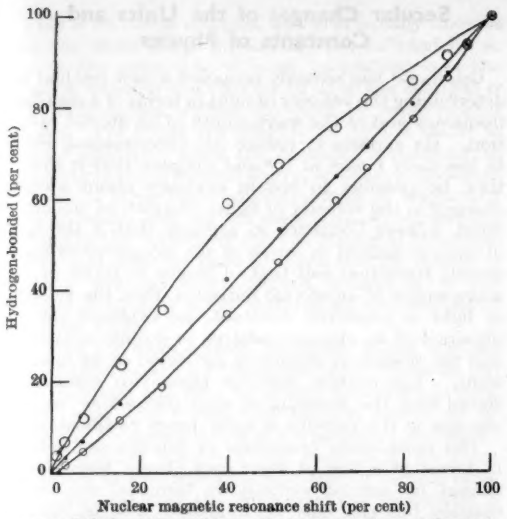


Fig. 1. Relation between degree of hydrogen bonding and chemical shift of the OH-proton in CH_3OH from its value in the un-hydrogen-bonded molecule: ○, percentage CH_3OH molecules in all forms of polymer; ●, percentage CH_3OH molecules in polymer with $n > 2$; ●, percentage CH_3OH molecules in polymer with $n > 2 + 32$ per cent CH_3OH molecules in dimer

reasonable estimate of the relative proportions of the three forms can be made), and (*b*) in experiments with sterically hindered alcohols which can form only dimer.

Fig. 1 shows for methanol the relation between the chemical shift and the percentages of: (*a*) total hydrogen-bonded species, (*b*) polymers with $n > 2$; and (*c*) polymer + 32 per cent of the amount of dimer. The chemical shifts are expressed as percentages of the total shift observed on passing from the pure liquid to an infinitely dilute solution containing only monomer. Since the pure liquid still contains about 10 per cent of monomer, the 'per cent polymer' plotted is the percentage of the amount in the pure liquid.

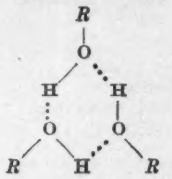
The linear relationship resulting in the last case holds reasonably well over the whole range from $< 0{\cdot}1$ molar, where only the monomer–dimer equilibrium is important, up to 2·5 molar solutions, which contain predominantly polymer. It shows that the contribution to the change in chemical shift of alcohol molecules in the dimeric form is—per molecule of CH_3OH—only about one-third of the value contributed by alcohol molecules in higher polymeric species.

We find this relation well borne out by the examination of sterically hindered alcohols such as methyl-ethyl-*t*-butyl carbinol, which, as the infra-red data show, can form only dimers. (Molecular models show that when two molecules are hydrogen-bonded, a third cannot get close enough to the hydroxyl group to interact.) In spite of the fact that the equilibrium constant for the monomer–dimer process is very close to that for methanol, the total shift, from pure substance to infinite dilution, is only 55 cycles, compared with 180 for methanol. The predicted value, using the relationship

$$\frac{\text{shift due to a molecule in dimer}}{\text{shift due to a molecule in polymer}} = 0{\cdot}32$$

is 57 cycles.

We believe that these large shifts are due to the fact that a considerable fraction of the polymer consists of cyclic species such as:



and that the effect can best be described by a 'circulating current' model where a paramagnetic shift results from the fact that the protons are largely outside the current loop. A simple calculation suggests that shifts of the observed order of magnitude may be expected if only a few per cent of a fully delocalized 6-atom orbital is mixed into the wave function representing the twelve electrons involved in the hydrogen bonding of the cyclic trimer.

In a recent review[3] Coulson estimates that the delocalization energy in a single O – H . . . O hydrogen bond is about 8 kcal. This means that the overlap energy between two oxygens at a distance of 2·7 A., making use of the H orbital to some extent, is of a similar magnitude to the exchange interaction between a pair of orbitals on the same oxygen atom (Coope, J. R., private communication). This provides a situation in which delocalization cannot be confined to a single O – H . . . O bond, but must embrace all six atoms. We thus have a system in which current circulation may occur through a system of σ bonds. This does not occur in the σ bond system of alicyclic compounds, of course, because of the great disparity between the high exchange energy in the C – C bond and that between orbitals on the same atom.

In the cyclic trimer, simple molecular orbital theory gives a set of nine orbitals, with only twelve electrons to be allocated. This allows three empty antibonding orbitals, so that the benefits of the bonding delocalized orbitals are not cancelled out by filled antibonding levels.

We believe that these proton resonance and infra-red results provide an experimental demonstration of such circulating currents, and that the magnetic behaviour of other hydrogen-bonded substances in solution (for example, the cyclic acetic acid dimer, and the non-cyclic dimers formed between chloroform and acetone or triethylamine[4]) are all consistent with our explanation.

The establishment of delocalization in hydrogen bonded systems has important implications in the area of polyelectrolytes, and suggests a mechanism whereby energy migration in proteins, or deoxyribonucleic acid-type molecules, may occur over relatively long distances if excitation is brought about at some point in the molecule as a result of a chemical process, or by irradiation.

In such a system, attenuation, because of vibrational dissipation of energy during transport, can be expected to be greater than in a network of conjugated double bonds, or other tightly coupled systems (at the short-bond turning point of the OH vibration, coupling is relatively poor[3]). However, this feature also provides a possible reason why, although a number of *in vivo* and *in vitro* phenomena suggest such delocalization, it is hard to find clear evidence

for it in the ultra-violet absorption spectra since, for the short time ($\simeq 10^{-15}$ sec.) required for ultra-violet absorption, the bonds are effectively localized and only delocalized when considered over times $> 10^{-14}$ sec.

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Density of Water adsorbed on Wyoming Bentonite

At the present time, two schools of thought exist concerning the density of water adsorbed on clays. Hendricks and Jefferson[1] and Macey[2] postulated structures for this adsorbed water which are less dense than free water; whereas, Williamson[3,4] and Mackenzie[5] have argued against these postulates and have suggested that the adsorbed water is denser than free water. Barshad[6] has proposed that the adsorbed water is closely packed at high states of hydration.

Attempts to measure the adsorbed-water density have been based on the pycnometer and X-ray methods. These methods have given contradictory results, probably because of the assumptions involved.

We compressed a clay–water paste between a porous filter and a column of mercury and observed, simultaneously, by means of capillaries, the change in volume of the clay paste and the volume of water forced through the filter. From these observations we were able to plot the volume of the clay paste against the weight of water in the paste. The slope of the line at any water content is the reciprocal of the water density at that water content.

By this method we obtained the densities of water adsorbed on homoionic Wyoming bentonites saturated with either lithium, sodium or potassium ions. We found that for each clay the water density decreased continuously with decreasing water content. At 25° C., and a water content of 0·6 gm. of water per gm. of clay (7·5 A. from the clay surface if the surface area is 8×10^6 sq. cm. per gm. of clay), the densities of the water on lithium, sodium and potassium clays were 0·975, 0·972 and 0·981, respectively. Thus, the adsorbed water is less dense than free water.

A detailed account of this research will be published in the *Proceedings of the Soil Science Society of America*.

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Secular Changes of the Units and Constants of Physics

Gerharz[1] has recently proposed a new method for determining the velocity of light in terms of a standard frequency and of the wave-length of an atomic radiation. He expects to reduce his experimental errors to less than 1 part in 10^8 and suggests that it should then be possible to obtain evidence about secular changes in the velocity of light. Dingle[2], on the other hand, follows Clemence in arguing that if the unit of time is defined in terms of the frequency of some atomic transition and that of length in terms of the wave-length of an atomic radiation, then the velocity of light is implicitly constant, no evidence can be obtained of its changes relative to atomic constants, and the science of physics is restricted at its foundations. The conflict between these two statements shows that the meaning of such phrases as 'secular changes in the velocity of light' needs clarification.

The measurable quantities of physics are defined in terms of a few of their own class; these latter cannot be defined verbally in terms of any other entities, but can only be indicated, that is, defined ostensively. Thus, taking length, mass and time as basic mechanical quantities, we can only indicate "*that* is length", but we can give velocity the verbal definition, "length per unit time". Since we can only define the basic quantities ostensively, we have to maintain material representations of them on which to found a system of units of these basic quantities, but once such a system is available, units of other quantities can be derived from their verbal definitions.

All physical measurements depend on comparisons of like quantities (in 'absolute' measurements the quantities compared are arranged to be fundamental quantities) and the comparisons are necessarily of the quantities at the same instant of time. If one wishes to compare A at time t_a with B at time t_b it is necessary to assume that one or other of them has not changed between t_a and t_b, and if one wishes to compare A at time t_1 with A at time t_2, it is necessary to assume that some other quantity that may be compared with A has not changed in the interval. In dealing with the material representations of the fundamental units, this assumption can be neither proved nor disproved by arguments based on other measurements, but can only be justified by arguments drawn from our general beliefs about the nature of physics. Thus, in deciding whether to derive the unit of time from the period of rotation of the Earth about its axis or that of its revolution about the Sun, the most that measurement can do is to tell us how the ratios of these periods to each other and to other observable periods have changed: the decision must be based on such theoretical considerations as the possible perturbations that may affect the motions or, bearing in mind the changes of the ratios of each to other periods, that it is more probable that one has changed than the other. A like situation arises in comparing the period of a certain transition of the cæsium atom with celestial periods.

It is clear, then, that with the fundamental quantities we cannot go beyond the material representations and that it is meaningless to speak of changes in the units. Such questions as whether the unit of length has changed are without meaning within the field of experimental physics.

This is no doubt obvious, and it is equally obvious that our ideas about physics are not affected by it. But at the same time it must be realized that the question whether the velocity of light has changed is also meaningless within the field of experimental physics. For either the velocity of light is taken as a basic quantity, when the question is meaningless according to the argument above, or else it is measured in terms of other basic quantities such as length and time, in which case we can determine experimentally changes in the velocity of light as measured in certain units. But then we have no experimental means of deciding whether any observed change is in the velocity of light or in the material representations of the basic units.

It does not seem correct, therefore, to say that we restrict physics at its foundations if we represent the units of length and time by atomic quantities in such a way that the velocity of light is forced to be constant. The restriction is in the nature of the experimental method itself—in the facts that we come ultimately to the ostensive definition of certain basic quantities and that the comparison of quantities is implicitly simultaneous.

The choice of basic quantities is, therefore, essentially one of convenience—primarily of practical convenience, for the basic comparisons should be very precise and the material representations readily accessible. Subject to these overriding considerations, there is much to be said for choosing a system of units conformable to the structure of the general theoretical framework of physics and in particular for choosing a system in which the velocity of light is implicitly constant.

In one class of quantities, however, secular changes do seem to be meaningful, namely, non-dimensional quantities such as the fine structure constant, and theoretical and experimental investigations of secular changes in physical 'constants' should be formulated in terms of such numbers.

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Distribution of Strontium-90 in Pond Weed and Fish

The opportunity recently occurred to investigate a few aspects of the distribution of strontium-90 in a balanced pond, during the course of experiments on the removal of fission products from drinking water. A derelict filter bed was utilized containing 1¼ million gallons of fresh water to which was added 500 millicuries of strontium-90 in equilibrium with yttrium-90. An extensive pure growth of *Myriophyllum spicatum* was present at the beginning of the experiment and large numbers of rudd (*Scardinius erythrophthalmus*) were observed.

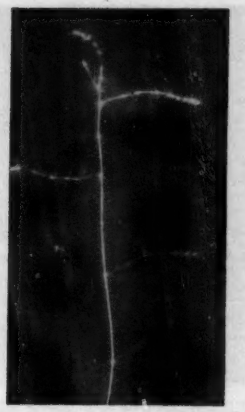

Fig. 1. Print of gross autoradiograph of *Myriophyllum spicatum*

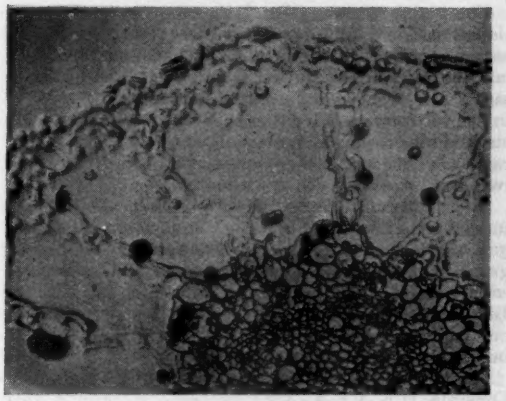

Fig. 2. Microautoradiograph of T.S. stem of *Myriophyllum spicatum* at node

Samples of *M. spicatum*, rudd and water were taken at intervals and radioassayed. Results are given in Table 1.

To locate the strontium-90 more accurately autoradiographs were made. The gross autoradiographs (Fig. 1) of the dried weed indicated a larger accumulation of strontium-90 at the nodes and in the inflorescences. Transverse sections of the stem were made after paraffin embedding and microautoradiographs prepared by Pelc's technique[1].

Table 1. Radioassay of *M. spicatum*, *S. erythrophthalmus* and Water expressed as Microcuries $\times 10^{-4}$ per gram Wet Weight

Days from zero	Water	Muscle	Skin	Scales	Bone	Gut	Gut contents	Gills	*M. spicatum*
42	0·28	0·76	—	—	15·6	1·26	—	25·6	101
133	0·29	0·68	—	—	26·8	6·03	36·6	41·9	60·4
272	0·19	0·37	1·6	53·2	11·0	0·50	1·6	6·7	45·4
Average	0·26	0·61	1·6	53·2	17·8	2·6	19·1	24·7	68·9
Accumulation factor*	1	2·4	6·2	208·6	69·8	10·2	74·9	96·9	270·2

* Accumulation factor = $\frac{\text{microcuries per gm. wet weight of tissue}}{\text{microcuries per ml. water}}$

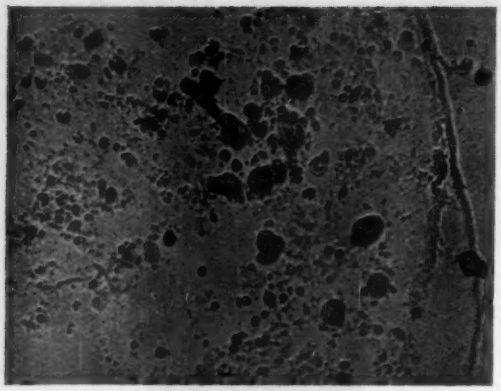

Fig. 3. Microautoradiograph of T.S. gut of *Scardinius erythrophthalmus*

The nodal sections (Fig. 2) showed that accumulation of strontium-90 was limited to crystals (probably calcium oxalate) in the cortex, the vascular tissue and the leaf traces. Martin[2] found an accumulation of strontium-90 in vascular tissues in beet and, notably, in the tertiary vascular tissue. Sections at internodes showed strontium-90 in crystals but less in the stelar region. This was in agreement with the gross autoradiographs of the *M. spicatum*.

Microautoradiographs of various fish tissues were made, including gill filaments, skin, flesh, bone and gut, and are included in the full report[3]. A photograph of the microautoradiograph of the transverse section of the ligatured gut is shown in Fig. 3. Blackening indicates the presence of strontium-90 on food particles; its absence from the gut wall is in agreement with the radioassay.

Acknowledgment is made to the Managing Director, U.K.A.E.A., for permission to publish this communication.

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Fractionation of Phosphorus Compounds in Ossifying Cartilage

The phosphorus compounds of ossifying cartilage from the long bones of various young animals have been fractionated into two components: (*a*) 20 per cent tri-chloracetic acid-soluble fraction; (*b*) acid-insoluble fraction.

The animals were injected intraperitoneally with phosphorus-32 as orthophosphate. The acid-insoluble fraction, representing 20–40 per cent of the phosphorus content, had a very low specific activity, only 2 per cent of the total phosphorus-32 radioactivity of the cartilage was isolated in this fraction. It is assumed that the acid-insoluble fraction is protein bound, and since it is no longer present in formed bone it would appear that it is involved in the process of cartilage formation. The absence of any appreciable radioactivity in this fraction, however, would indicate that it plays no significant part in the calcifying mechanism.

The acid-soluble fraction, which contained 98 per cent of the phosphorus-32 activity in cartilage, has been further fractionated by the use of paper chromatography.

Lutwak-Mann[1] was unable by conventional means to demonstrate the presence of organic ester-phosphate in the acid-soluble extract due to the large excess of orthophosphate. Albaum[2], however, found adenosine triphosphate in preosseous tissue, enzymatically using a specific deaminase/spectrophotometric method. The main difficulty in the separation of phosphorus compounds by chromatography is the inhibitory effect of divalent ions. The effect is not so apparent in acid solvents; but it made two-dimensional chromatography, using an alkaline solvent in the second run, impossible. Numerous solvents were tried, but the best appeared to be *tert.*-butanol (80 c.c.) – water (20 c.c.) – tri-chloracetic acid (4 gm.).

The animals are injected with an amount of phosphorus-32 (0·33 mc./kilogram) in the form of orthophosphate. After 2 hr. the animal is killed, the cartilage quickly removed, and cleaned of all bone and muscle. The cartilage is placed in liquid nitrogen and crushed. The resultant powder is extracted with 1·5–4·0 ml. of 5 per cent trichloracetic acid for 30 min. with constant stirring. The mixture is centrifuged and the supernatant removed. 0·15–0·3 ml. of this extract is applied to the Whatman No. 4 paper, and the chromatogram run in the solvent for 40–60 hr. at 13–15° C. using the descending chromatographic technique. This allows for the separation of adenosine triphosphate, adenosine diphosphate and adenosine monophosphate. The R_{op} values, that is, the distance travelled with respect to orthophosphate, are approximately 0·2, 0·4 and 0·8 respectively.

The cartilage extract gives two definite spots. They are detected by means of the Hanes and Isherwood[3] spray for phosphate esters, and the purine compounds by the ultra-violet photographic method of Markham and Smith[4].

The largest spot is the orthophosphate from the calcified matrix. The other main spot has been identified as adenosine triphosphate by the following tests: (*a*) It runs the same distance as adenosine triphosphate in varying temperature conditions and is opaque to ultra-violet light when photographed. (*b*) On eluting out the spot an absorption peak at 260 mμ is obtained. The eluate also gives a positive test for pentose sugar (probably ribose). (*c*) It is chemically a phosphate compound. In addition, two further compounds are detected in trace amounts by the ultra-violet method. They correspond to adenosine diphosphate and adenosine monophosphate. No other phosphate compounds could be detected.

The adenosine triphosphate and orthophosphate were estimated quantitatively by ashing the corresponding area of the chromatogram and dissolving the ash in the amount of sulphuric acid required for the Berenblum and Chain[5] method which was used in the phosphorus estimations. The radioactivity measurements were made in a liquid counter using

TABLE 1. SPECIFIC ACTIVITY OF PHOSPHORUS-32 INCORPORATED IN ADENOSINE TRIPHOSPHATE (ATP) AND ORTHOPHOSPHATE OF CARTILAGE
(The specific activities are calculated according to Weidmann (ref. 6))

Age in days	Cat litter-mates												Dog litter	
	1		2		3		4		5		6			
	ATP	Ortho-phos-phate	ATP	Ortho-phos-phate	ATP	Ortho-phos-phate	ATP	Ortho-phos-phate	ATP	Ortho-phos-phate	ATP	Ortho-phos-phate	ATP	Ortho-phos-phate
0			15,000	30,000	33,000	52,000	16,000	42,000			16,000	31,000	44,000	75,000
6					29,000	50,000	15,000	43,000			25,000	54,000	42,000	66,000
9			19,000	45,000										
15	29,000	61,000	18,000	45,000			15,000	40,000						
21	23,000	41,000	20,000	46,000					21,000	35,000	21,000	50,000		
28					19,000	37,000							30,000	60,000

the above solution before chemical estimations were carried out.

Using litter-mate puppies and kittens, a serial analysis with age gave the following results, which are expressed graphically in Fig. 1.

There appears to be a gradual diminution of the concentration of adenosine triphosphate with increased development of the cartilage. During this period an increase in the calcium/phosphorus ratio from 1·1–1·8 was also measured. There was no corresponding increase in the adenosine diphosphate or adenosine monophosphate content of the cartilage. The amount of adenosine triphosphate corresponding to the above phosphorus values is in newly born animals 36–38 mgm. per 100 gm. wet wt. of cartilage falling to 20 mgm. per cent in 4-week old kittens. This compares favourably with 35 mgm. per cent obtained by Albaum[2] for rat cartilage.

This chromatographic method is an improvement on that of Albaum[2] in that actual separation of adenosine triphosphate is achieved, and hence radioactivity associated with it can be measured.

These figures show a high specific activity in the adenosine triphosphate, but assume the activity to be equal in all three phosphate groups. This is certainly not true for other tissues, and the value of the terminal group may be considerably higher and be comparable to that of the orthophosphate and consequently be a possible precursor.

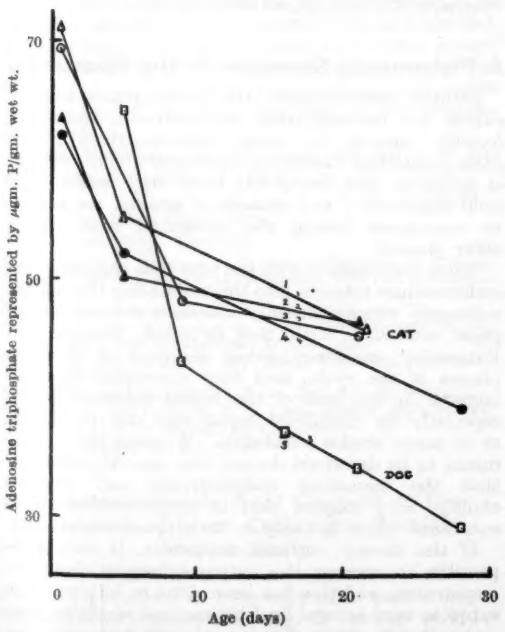

Fig. 1. Variation of adenosine triphosphate. Concentration in cartilage with age. Cat litters, 1, 2, 3, 4; dog litter, 5

The adenosine triphosphate concentration in cartilage is about one-tenth that of muscle, but is about the same value as liver and kidney, and represents quite a rich source of ester-phosphate. Cartier and Picard[7] have shown, using *in vitro* techniques, that adenosine triphosphate gives rise to much more rapid calcification than other esters. In addition, the *p*H maximum of adenosine triphosphate utilization is much nearer the physiological *p*H than with the other esters. Reis[8] has shown the presence in cartilage of 5-nucleotidase. This enzyme has a much higher activity at the physiological *p*H than alkaline phosphatase. Perkins[9] has demonstrated a high activity of adenosine triphosphatase in bone.

This idea that adenosine triphosphate may be an important intermediate in calcifying mechanism is strengthened by our findings that adenosine triphosphate is the only acid-soluble phosphate ester which accumulates due to the glycogenolysis in ossifying cartilage. The high specific activity of the incorporated phosphorus-32 in adenosine triphosphate is consistent with this idea and is supported by the fall in adenosine triphosphate concentration as calcification proceeds.

Fuller details of this work will be published elsewhere. This work has been supported by a grant from the Medical Research Council.

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Effect of Analogues on the Uptake of Vitamin B_{12} by the Intact Rat

THE normal mechanism of absorption of vitamin B_{12} from the small intestine is a specialized one. In order to determine the part played by molecular configuration we have administered vitamin B_{12} analogues and studied their effect upon the absorption of the vitamin by the intact rat. Under these conditions, inhibition is probably due to competition for absorption or possibly to blockage of some part of the absorption

mechanism. If no inhibition occurs then we can deduce that the difference in molecular structure has rendered the substance incapable of participation in the absorption system.

The analogues available to us were pseudovitamin B_{12}, a mixture of the monoethylamides, desdimethyl B_{12} and vitamin B_{12} lactone (Fig. 1). Pseudovitamin B_{12} contains adenine in place of the 5 : 6 dimethylbenziminazole of the vitamin molecule. The mixture of ethylamides consists of each of the three isomeric monoethylamide derivatives of a single propionamide side-chain. Desdimethyl vitamin B_{12} lacks the methyl groups of the benziminazole moiety. The lactone is formed on ring *B* (Fig. 1).

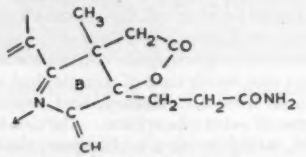

Fig. 1. Vitamin B_{12} lactone. Only ring *B* is shown, the remainder of the molecule is identical with cyanocobalamin

Young adult rats which received neither food nor drink for 16 hr. were given 1·5 ml. of a solution containing either 15 mμgm. of radioactive vitamin B_{12} alone or together with 1,500 mμgm. of an analogue. 5 hr. later each animal was killed by a blow on the head. The stomach, the intestine and its contents, and the liver were removed. The liver was weighed, and the three organs were separately dissolved in sulphuric acid[1]. The final volume of each solution was made up to 200 ml. with water, and the radioactivity determined in a scintillation counter containing a sodium iodide crystal of 2-in. diameter and 1 in. long, a re-entrant container and lead shielding at least 3½ in. thick[2]. By comparison with the radioactivity of a standard radioactive vitamin B_{12} solution the counts were converted to absolute amounts.

The results are shown in Table 1. The total uptake of the vitamin was determined by subtracting the amount in the stomach and intestine from the dose administered. The stomach content was always low. The liver uptake is expressed as μμgm./gm. wet weight of liver.

The radioactivity of the liver was a measure of uptake of the vitamin, and in all cases this measurement has correlated very well with the intestinal measurements.

Table 1

Substance administered	Total B_{12} uptake (mμgm.)	Mean total uptake (mμgm.)	Liver uptake (μμgm./gm.)	Mean liver uptake (μμgm./gm.)
B_{12} alone	7·7 6·8 4·5 2·8 7·7 6·2 2·9 5·9	5·5	— — 41·8 49·0 69·5 77·0 39·7 62·2	56·5
B_{12} + pseudovitamin B_{12}	6·2 6·8 2·7	5·2	— — 42·5	42·5
B_{12} + desdimethyl B_{12}	0·6 0·5	0·55	5·5 14·5	10·0
B_{12} + monoethylamides	2·95 0·6	1·8	12·0 9·8	10·9
B_{12} + B_{12} lactone	5·9 8·3	7·1	74·7 44·3	59·5

Pseudovitamin B_{12} did not inhibit the uptake of the vitamin. Evidently the benziminazole moiety is a necessary part of the molecule for the absorption process. Desdimethyl B_{12} did compete with the vitamin, and it must therefore be the benziminazole ring itself which is necessary.

If the acetamide side-chain of ring *B* is altered as in the lactone then the substance does not inhibit vitamin uptake. The mixture of monoethylamides interfered with uptake; in this case the acetamide side-chain on ring *B* is undisturbed.

From this evidence we can conclude that for absorption by the vitamin B_{12} system in the small intestine the benziminazole moiety of the 'nucleotide' portion of the molecule must be intact, although not necessarily methylated. A major alteration in the acetamide side-chain of ring *B* results in a loss of competitive activity.

Although we were using a hundred times the concentration of analogue to vitamin, in those instances in which the uptake was inhibited the absorption of the vitamin was diminished to approximately one-tenth. It seems reasonable to conclude that even where the analogue can take part in the absorption system the latter is still more specific for vitamin B_{12} than for the analogue.

We wish to thank Dr. J. J. Pfiffner for the pseudovitamin B_{12} and Dr. E. Lester Smith for the other analogues as well as the radioactive vitamin.

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A Plain-muscle Stimulant in the Menstruum

During menstruation, the myometrium actively expels the disintegrating endometrium, sometimes forcibly enough to cause dysmenorrhœa[1]; the gastro-intestinal motility is increased[2]; if the subject is lactating, her breast-fed baby may suffer from mild diarrhœa[3]; and attacks of asthma are said to be commoner during the menstrual than during other phases[4].

These facts accord with the idea that the menstrual endometrium releases into the circulating blood some substance which generally increases the activity of plain muscle. With this in mind, Sieburg and Patzschke[5] examined sweat secreted at different phases of the cycle, and they concluded that the increase in the tone of the rabbit intestine caused especially by menstrual sweat was due to choline or to some similar substance. Whereas the experiments to be described do not rule out the possibility that the menstrual endometrium may produce choline, they suggest that it forms another active substance which is likely to be a lipoid-soluble acid.

If the theory outlined is correct, it should be possible to recover the active substance from the menstruum, and this has been done as follows. The subjects were several healthy medical students who, under the direction of a woman colleague were provided with vessels containing a 50 per cent acetone–

water mixture into which they put the usual perineal or vaginal dressings immediately they were discarded. The 50 per cent acetone extract was evaporated to dryness and then taken up in pure acetone or chloroform; this was added to Ringer's solution, the organic solvent evaporated off, and the *p*H, which was usually about 5, adjusted to 7·4 with sodium hydroxide. Control extracts of unused dressings were also made, and were found to have no effect.

The menstrual extracts showed two kinds of effect on plain muscle. One was a direct stimulation, shown by a slow increase in tone and in the amplitude of any spontaneous contractions. This was repeatedly demonstrated on the guinea pig ileum, the rabbit small intestine and uterus and the rat colon. Contrary to the findings of Sieburg and Patzschke[5], this effect was not abolished by atropine (10^{-6} or 10^{-5} gm./ml.), although with this treatment the preparations became generally less sensitive to the menstrual extracts as well as to histamine and hydroxytryptamine. Mepyramine and lysergic acid (10^{-6} gm./ml.) also failed to abolish the response.

The other effect of the menstrual extracts was to potentiate the action of certain other plain-muscle stimulants. Amounts of the extracts too small to cause more than a very slight contraction of the guinea pig ileum nevertheless, after being in the organ bath for 1–3 min., greatly increased the response to either acetylcholine or to histamine. The potentiation rapidly disappeared when the extract was washed out. The contractile response of the rat vas deferens to adrenaline was similarly potentiated; so also was that of the guinea pig seminal vesicle. In neither of these latter cases did the extracts alone cause any contraction. Macht and Davis[6] described a similar effect of 'mentoxin' on the rat vas deferens, and von Euler[7] a somewhat similar effect of prostaglandin on the guinea pig seminal vesicle.

The pharmacological and solubility properties of the active substance, so far as they have been studied, indicate that it is a lipoid-soluble acid of the general type reviewed by Vogt[8]. Its physiological significance is a matter for conjecture, but it provides a possible explanation of the facts described in the opening paragraph.

These findings were communicated orally to the Physiological Society at Oxford on July 19–20.

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Deoxyribonucleic Acid Content of the Nucleus of Liver Cells after Partial Hepatectomy

Modifications in the deoxyribonucleic acid content of the nucleus of liver cells after partial hepatectomy were recently described in the rat[1] and the guinea pig[2]. We tried to observe this phenomenon in the mouse. Hepatectomy was performed in fifteen

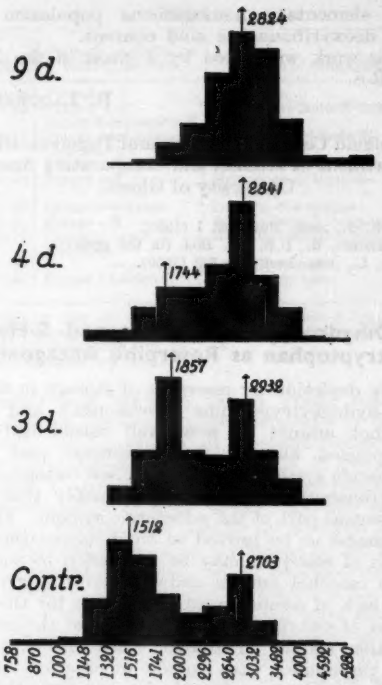

Fig. 1. Histograms of the deoxyribonucleic acid content of the nuclei of liver cells in a control and 3, 4 and 9 days after partial hepatectomy. The mean deoxyribonucleic acid contents of the different nuclear classes are indicated by the arrows and given in arbitrary units

specimens. Nearly one-fifth of the gland was removed by cautery. Three groups of 5 animals each were killed respectively 3, 4 and 9 days after intervention. Traces of neither infection nor haemorrhage were present. Fragments of the operated livers and of 4 control livers were fixed in a mixture of 80 parts of alcohol 96 per cent, 15 parts of formalin, 5 parts of acetic acid, dehydrated and embedded under strictly standardized conditions. Sections of the different livers were placed on the same slide, to assure an identical Feulgen-reaction. In each of the 10μ-thick sections, the deoxyribonucleic acid content of 200 nuclei was determined *in situ* by means of L. Lison's histophotometrical method[3].

In Fig. 1 are represented the histograms of the results obtained for one typical liver of each group (in the other liver comparable results were found). In the control the well-known nuclear-classes of mouse-liver were found—a diploid and a tetraploid class and some sporadic octoploid nuclei. In the treated livers the relative number of the nuclei of the diploid class decreases in favour of the tetraploid class, while the mean value of deoxyribonucleic acid content of the remaining diploid nuclei increases progressively. The mean value of the tetraploid elements remains unchanged; 9 days after intervention there is a complete fusion of the two classes around the tetraploid mean value. The small number of octoploid nuclei does not vary.

After partial hepatectomy in mice, a precocious and progressive increase of the deoxyribonucleic acid content of the diploid liver cell nuclei occurs. Those nuclei form finally with the originally tetra-

ploid elements a homogeneous population as to their deoxyribonucleic acid content.

This work was aided by a grant of the Belgium F.N.R.S.

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3,4-Dihydroxyphenylalanine and 5-Hydroxytryptophan as Reserpine Antagonists

The depletion by reserpine of storage in the body of 5-hydroxytryptamine ('Serotonin') and of the catechol amines is now well established[1-3]. In reserpinized animals the peripheral part of the adrenergic system does not function owing to lack of the transmitter[3]. This is presumably true also of the central part of the adrenergic system. However, it remains to be proved to what extent the central action of reserpine may be attributed to changes in brain catechol amines and/or 5-hydroxytryptamine.

If lack of amines were responsible for the central action of reserpine, administration of the amines in question should counteract these effects, provided that the amines were capable of entering the brain. However, 5-hydroxytryptamine has been shown not to penetrate the blood-brain barrier readily[4], and this may be true also of the catechol amines. This difficulty may be overcome by administering the amino-acid precursors of the amines. Thus injection of 5-hydroxytryptophan is followed by an increase in the level of 5-hydroxytryptamine in brain as well as by central excitation[4]. Preliminary experiments in this laboratory have shown that in this respect 3,4-dihydroxyphenylalanine, which is the precursor of the catechol amines (dopamine, noradrenaline, and adrenaline), behaves similarly.

Experiments were performed on mice (males weighing about 10 gm.), which received an intraperitoneal injection of reserpine (20–40 mgm. per kgm.). After about 16 hr., when the animals were markedly tranquillized and showed complete ptosis of the eyelid, 5-hydroxytryptophan, 3,4-dihydroxyphenylalanine, or a mixture of both amino-acids (in the DL-form throughout) were injected intraperitoneally. In doses up to 1,000 mgm. per kgm. 5-hydroxytryptophan was unable to antagonize the tranquillizing action of reserpine: ptosis persisted. On the other hand, the response to 3,4-dihydroxyphenylalanine was dramatic. Within 15–30 min. after a dose of 500–1,000 mgm. per kgm. the animals resumed almost normal behaviour or even showed signs of overactivity, and ptosis disappeared. The effect did not last much longer than an hour, after which the animals gradually returned to the same condition as before the injection of 3,4-dihydroxyphenylalanine. Although 5-hydroxytryptophan given alone had no effect, a mixture of equal amounts of 5-hydroxytryptophan and 3,4-dihydroxyphenylalanine 250–500 mgm. per kgm.) produced a more complete and longer-lasting counteraction of the reserpine effect than did the same dose of 3,4-dihydroxyphenylalanine alone.

A dramatic effect of 3,4-dihydroxyphenylalanine (200 mgm. per kgm. intravenously) was observed also in rabbits which had received reserpine in a dose of 5 mgm. per kgm. intravenously 4 hr. earlier. Within 10–15 min. after the injection of 3,4-dihydroxyphenylalanine the tranquillization as well as ptosis and meiosis caused by reserpine had disappeared completely. If the animal had received iproniazid (100 mgm. per kgm. intravenously) about 2 hr. before the 3,4-dihydroxyphenylalanine, the dose of the latter required to antagonize the effect of reserpine was markedly reduced. This supports the assumption that the effect of 3,4-dihydroxyphenylalanine was due to an amine formed from it. (The iproniazid, when administered about two hours after the reserpine as in these experiments, did not *per se* counteract the tranquillizing effect of reserpine.) In normal rabbits 3,4-dihydroxyphenylalanine caused central stimulation, which was likewise markedly potentiated by iproniazid pretreatment.

A full account of these experiments will be published elsewhere.

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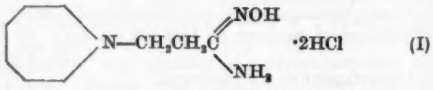
Antihypertensive Activity of Hexahydro-1-Azepinepropionamidoxime

Hexahydro-1-azepinepropionamidoxime dihydrochloride (I), designated as *SU*-4029, has been studied for its effect on the cardiovascular system of the dog.



(I)

A single intravenous dose of 30 mgm./kgm. of this compound lowered the arterial pressure of neurogenic and renal hypertensive dogs while not notably affecting the blood pressure of normotensive dogs. However, in normotensive animals 30 mgm./kgm. of *SU*-4029 given intravenously eliminated the severe hypertension elicited by high doses of amphetamine and ephedrine and also markedly antagonized carotid occlusion reflex pressor responses. These antihypertensive effects were slow in onset and lasted for approximately two to six weeks following single injection. *SU*-4029 was orally active and had a cumulative action when given in small daily doses.

To prepare the compound, hexahydroazepine was cyanoethylated and gave hexahydro-1-azepinepropionitrile[1], b.p. 121–123°/14 mm.; n_D^{30} 1·4710 (found: C, 70·82; H, 10·52; N, 18·53 per cent. $C_9H_{16}N_2$ requires: C, 71·11; H, 10·61; N, 18·43 per cent). Treatment of this nitrile with hydroxyl-

amine in ethanol yielded the desired amidoxime which could be converted to the dihydrochloride salt with ethanolic hydrogen chloride; recrystallization from ethanol gave material that melted with decomposition at 183–185° (found: C, 42·01; H, 8·43; N, 16·22; Cl, 27·28 per cent. $C_9H_{18}N_4O$. 2HCl requires: C, 41·90; H, 8·20; N, 16·29; Cl, 27·49 per cent).

Numerous structurally related compounds have been prepared and their pharmacological activity investigated. Alteration of the side-chain and ring-size usually resulted in diminution of the aforementioned antihypertensive properties.

SU-4029 is at present being tested clinically, and the results as well as chemical and pharmacological studies will be published *in extenso* at a later date.

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Oligosaccharides of Human Milk

THE presence of fucose as a constituent sugar in oligosaccharides obtained from human milk was reported by Kuhn[1] in 1952. Since that time Kuhn and his associates have characterized four oligosaccharides from this source, in all of which fucose is found: a trisaccharide, fucosido-lactose; two pentasaccharides referred to as lacto-N-fucopentaoses I and II, and a hexasaccharide, lacto-N-difucohexaose; the last three are derivatives of a common, fucose-free parent compound—lacto-N-tetraose[2]. Montreuil, in a series of communications, has reported the occurrence of compounds probably identical with those analysed by Kuhn, and in addition, a further range of fucose-containing substances of still greater complexity[3]. He has isolated thirteen sugar compounds, other than lactose, from human milk, all of which contain galactose and glucose and most of them fucose and acetylglucosamine as well.

There seems little doubt that these compounds isolated by Montreuil are in many cases identical with the series of compounds which we have ourselves obtained from human milk samples by rather different fractionation procedures. However, our agreement with this author does not always extend to his estimates of the molecular proportions of the various hexose units in his original compounds, and we give in Table 1 a summary of our own results, based on a study of the relationships existing between these oligosaccharides such as can be shown by their hydrolysis under very mild conditions. By correlating these results with analyses given by a modification of the method of Dische and Shettles for fucose[4], designed to give a simultaneous estimation and characterization of the non-fucose 'core' of the molecule in addition to a simple fucose analysis, we are able to suggest the probable identity of this range of compounds.

The substances analysed here account almost quantitatively for the total fucose in the original unfractionated milk samples, and it would therefore appear that all the fucose oligosaccharides of human milk, with the exception of fucosido-lactose and possibly the compound, or compounds, in fraction *A* (see Table 1), may be regarded as derivatives of lacto-N-tetraose or of a di- or tri- polymer of this compound. We may add that so far we have identified only one mono-fuco-lacto-N-tetraose (cf. ref. 2) and only one fucosido-lactose (cf. ref. 3), and also that trilacto-N-tetraose, which might be expected to occur as a member of our series, has not yet been observed except, on chromatograms, as the probable primary product of the mild hydrolysis of compound *C*.

Table 1

Fraction	*Rf**	Primary products on mild hydrolysis	Type of compound
A	0·08	Fucose + ?	? mixture
B	0·13	Fucose + *C*	Di-fuco-tri-lacto-N-tetraose
		Lacto-N-tetraose + *D*	
C	0·17	Fucose + tri-lacto-N-tetraose (?)	Mono-fuco-tri-lacto-N-tetraose
D	0·28	Fucose + *E*	Di-fuco-di-lacto-N-tetraose
E	0·43	Fucose + *F*	Mono-fuco-di-lacto-N-tetraose
F	0·55	Lacto-N-tetraose	Di-lacto-N-tetraose
G	0·64	Fucose + *H*	Di-fuco-lacto-N-tetraose†
H	0·77	Fucose + Lacto-N-tetraose	Mono-fuco-lacto-N-tetraose‡
I	1·00	—	Lacto-N-tetraose
J	1·43	Fucose + Lactose	Fucosido-lactose

* *Rf*, distance run by spot/distance run by lacto-N-tetraose on Whatman 3*MM* paper. Solvent: ethyl acetate/pyridine/water (ref. 5).
† Lacto-N-difucohexaose (ref. 2).
‡ Lacto-N-fucopentaose (ref. 2).

A full account of our methods and results will be published elsewhere.

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Use of Goose Cells in Hæmagglutination Tests with Arthropod-borne Viruses

HÆMAGGLUTINATION studies with arthropod-borne viruses are normally carried out using red blood cells from one-day-old chicks, although cells from mature pigeons have been used in the case of Murray Valley encephalitis virus[1]. An observation made in the West African Council for Medical Research Laboratories in Lagos that cells from mature ducks were agglutinated by a yellow fever antigen led to a study of readily available domestic birds. Cells from Muscovy ducks (*Cairina maschatai*), from a local (Badagri) variety of the domestic duck (*Anas boscas*) and from Chinese geese (*Cygnopsis cygnoides*) were compared with cells from one-day-old chicks against yellow fever, Uganda *S*, Zika and West Nile antigens. Goose cells gave titres which were at least as high as those obtained with chick cells, and usually higher, and the settling patterns were consistently sharp and easy

Table 1. Hæmagglutination Titres of Various Antigens Tested against Chick and Goose Cells

Group	Antigen*	Chick Titre	Chick pH	Chick Temp. (° C.)	Goose Titre	Goose pH	Goose Temp. (° C.)
A	V.E.E.	3,200	6·0	37	6,400	6·0	37
	E.E.E.	6,400	6·3	37	25,600	6·3	37
	W.E.E.	3,200	6·4	37	6,400	6·4	37
	Sindbis	3,200	6·2	37	6,400	6·2	37
	Chikungunya	800	6·2	37	1,600	6·2	37
	Semliki Forest	3,200	6·4	37	6,400	6·4	37
	Mayaro	100	6·2	22	200	6·2	22
B	Yellow fever, Asibi	800	6·2	22	1,600	6·2	22
	Yellow fever, 17*D*	20	6·2	22	80	6·2	22
	St. Louis	1,600	6·8	22	3,200	6·3	22
	Egypt 101	1,600	7·0	22	6,400	6·8	22
	Ilheus	3,200	6·4	22	6,400	6·4	22
	Trinidad 1751	800	6·4	22	1,600	6·4	22
	Uganda *S*	800	6·7	22	1,600	6·7	22
	Zika	20	6·5	22	40	6·5	22
C	Be. An. 15	Not tested			800	6·2	22
	Be. An. 17	80	6·0	22	160	6·0	22
Others	Bunyamwera	1,600	6·2	22	3,200	6·2	22
	Naples sandfly fever	80	6·2	37	160	6·6	37
	Sicilian sandfly fever	40	6·2	37	80	6·6	37

* For details of these viruses, see Casals (ref. 2)

to read. Duck cells, although agglutinated, gave lower titres and showed a tendency to spontaneous agglutination in controls. Goose cells were thereafter used as a routine in the Lagos laboratory, and experience over more than a year has shown them to be highly satisfactory in hæmagglutination and hæmagglutination-inhibition tests with the antigens already mentioned, and in addition with antigens prepared against Semliki forest, Ilheus and the Trinidad 1751 strain of dengue virus. Details of this work will be published elsewhere.

While on a visit to the Rockefeller Foundation Virus Laboratories in New York, it became possible to confirm and extend these observations. Antigens of known activity against one-day-old chick cells were tested against cells obtained from mature Toulouse geese (*Anser cinereus*, the common white domestic goose). Where comparative tests were carried out, titres with goose cells were as a rule one dilution higher than with chick cells (see Table 1). The *p*H range over which agglutination occurred was frequently broader with goose cells, and the tests were generally sharper and easier to read. Hæmolysis, a common finding with group *A* antigens, was less marked with goose cells, which appeared to be generally more stable than one-day-old chick cells.

So far, no antigen which is active against chick cells has been found to be inactive against goose cells. The increased sensitivity of goose cells may be valuable when antigens of low titre are being examined. The practical convenience of bleeding mature geese from a wing vein as compared with the bleeding of one-day-old chicks need scarcely be stressed. The only disadvantage so far encountered has been the finding that naturally occurring agglutinins for goose cells in human and animal sera are somewhat more common than are agglutinins for chick cells in the same sera. However, a simple absorption with normal goose cells readily removes this difficulty, and has been adopted as a routine in the preparation of sera for inhibition tests.

I thank Dr. F. N. Macnamara, director of the West African Council for Medical Research Laboratories, Lagos, and Dr. M. Theiler, director of the Rockefeller Foundation Virus Laboratories, New York, for their interest and encouragement; also Dr. J. Casals and Dr. D. H. Clarke, who generously provided many of the antigens used in New York.

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Coagulant Action of Proteolytic Enzymes

Eagle and Harris[1] demonstrated that the coagulant actions of papain and trypsin differ. Trypsin acts by converting prothrombin to thrombin: papain clots fibrinogen directly. The thrombin-like action of papain on fibrinogen has been ascribed to its proteolytic property[2,3]. Light-scattering studies on the papain–fibrinogen reaction[4] have shown that the extent of polymerization of fibrinogen is roughly of the same order as in the thrombin–fibrinogen reaction.

Although Sherry *et al.*[3] include ficin in a list of substances producing coagulation of fibrinogen, careful search of the literature fails to reveal any other reference to the coagulant action of this enzyme.

Two specimens of crude ficin powder were tested against human plasma and purified human and bovine fibrinogen. Typical results with human fibrinogen may be seen in Table 1. Both ficin preparations proved to be approximately equally potent. At a concentration of 1 mgm./ml. they were actively fibrinogenolytic; at lower concentrations they caused coagulation of the fibrinogen. Similar results were obtained with plasma and bovine fibrinogen.

Table 1. Coagulation of Human Fibrinogen by Ficin

Ficin concentration (mgm./ml. of mixture)	Clotting time (sec.) Preparation 1	Clotting time (sec.) Preparation 2
1·0	no clot*	no clot*
0·5	20	20‡
0·25	26	22
0·12$_5$	96	85
0·06$_3$	180	165
0·03$_1$	600	600

Clotting mixture: 0·2 ml. 0·4 per cent human fibrinogen, 0·1 ml. 0·8 per cent sodium chloride and 0·1 ml. ficin.
* After 5 min., 0·1 ml. thrombin added: no clot after another 5 min. (thrombin control: 10 sec.).
The human fibrinogen was prepared by the ether precipitation method (ref. 12).
One specimen of ficin was obtained from Merck and Co., Rahway, New Jersey, and the other from Light and Co., Poyle, Bucks.

These findings confirm the assertion of Sherry *et al.* that ficin possesses a thrombin-like action. Using mixtures containing purified prothrombin, purified Factor V, calcium, and ficin at various concentrations, careful search was made for any evidence of activation of prothrombin. At certain concentrations of enzyme, prothrombin was rapidly destroyed, but no evidence of thrombin formation was obtained. Exactly similar results were obtained with papain, confirming the work of Eagle and Harris.

Eagle[5] also noted that certain proteolytic snake venoms which coagulated fibrinogen directly (*Bothrops*, *Crotalus* species) were not inhibited by the powerfully antithrombic plasma of an anaphylactically shocked dog. This was also true of papain. In view of the subsequent discovery that the anti-

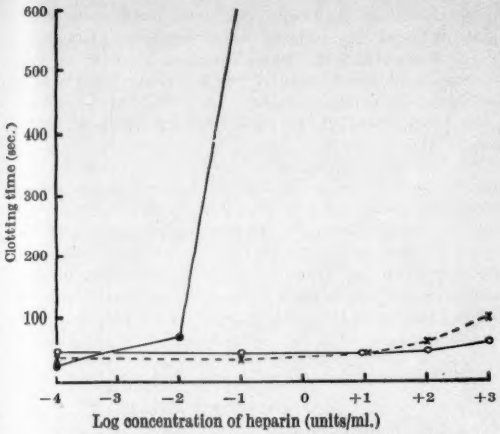

Fig. 1. Effect of heparin on coagulation of plasma by thrombin, papain and ficin. Clotting mixture: 0·2 ml. human citrated plasma, 0·1 ml. heparin at various concentrations, and 0·1 ml. thrombin, papain or ficin. The concentrations of thrombin, papain and ficin were adjusted to give a similar initial clotting time

thrombic material appearing in anaphylactic shock was heparin[6], direct determination of the effect of heparin on the coagulant ability of these proteolytic enzymes seemed important.

The action of heparin on thrombin, papain and ficin is shown in Fig. 1. At a heparin level of 0·1 unit/ml., plasma was incoagulable by thrombin. On the other hand, both papain and ficin were not inhibited by heparin. The slight prolongation of clotting time at very high heparin levels was probably due to the acid nature of heparin.

Eagle and Harris[1] noted that the clot produced by papain was softer than a normal clot. However, it has been stated that a papain-produced clot is similar to a normal clot when viewed by dark-field microscopy[7] or electron microscopy[8].

Present findings indicate that clots produced by papain and ficin are quite distinct from clots produced by the normal thrombic mechanism. If plasma or fibrinogen is clotted by papain or ficin without manipulating the tube, a bulky clot grossly similar to a normal one forms. However, the tensile strength of this coagulum is considerably lower than the normal. If the tube containing the clotting mixture is continuously tilted during coagulation, a small flocculent coagulum is produced; this contrasts markedly with a normal clot produced by thrombin in similar circumstances. When both types of coagulum were viewed by dark-field microscopy, it was found that the enzyme-produced clots were relatively deficient in fibrin strands. Those that did appear were small and late in development. The highly organized network characteristic of a normal coagulum was absent in the enzyme-produced clots.

The differences in clot morphology and in behaviour towards heparin between normal and enzyme-produced clots suggest that, though similar in general form, the coagulant action of proteolytic enzymes does not exactly correspond to that of thrombin. Papain and ficin have much broader specificities for synthetic substrates and native proteins than thrombin[2,9–10]; perhaps they attack the fibrinogen molecule at different sites than thrombin and produce a somewhat different fibrin.

Reasoning from differences in solubility between normal and venom-induced clots, Janszky[11] has also concluded that coagulation produced by proteolytic venoms was not identical with that produced by thrombin.

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Structure of a New Pyridine Nucleotide isolated from *Penicillium chrysogenum*

In the course of a study of the acid-soluble nucleotides occurring in the mycelium of *Penicillium chrysogenum*[1] we isolated a compound having a typical adenosine ultra-violet spectrum, and showing the appearance of a peak at 315 mμ on addition of potassium cyanide. This compound could be distinguished from diphosphopyridine nucleotide and triphosphopyridine nucleotide not only by its inability to act as a coenzyme for alcohol dehydrogenase and for glucose-6-phosphate dehydrogenase but also by the fact that it was eluted by formic acid from a 'Dowex-1' (formate) column behind diphosphopyridine nucleotide and before triphosphopyridine nucleotide.

Chemical and enzymic degradations of the above nucleotide have yielded results which provide strong evidence to indicate that it is the nicotinic acid analogue of diphosphopyridine nucleotide. Treatment of the compound with 0·1 *M* hydrochloric acid (2·5 hr. at 100° C.) resulted in the liberation of nicotinic acid, adenine and ribose-5-phosphate, whereas in the same experimental conditions not a trace of nicotinic acid was formed from diphosphopyridine nucleotide. On incubation with beef-spleen diphosphopyridine nucleotidase[2], nicotinic acid and adenosine diphosphate–ribose were produced, as compared with diphosphopyridine nucleotide which liberated nicotinamide and adenosine diphosphate–ribose. Using the molar extinction coefficient reported for diphosphopyridine nucleotide[3] the following molar ratios of adenine, nicotinic acid, pentose and phosphate were found: 1·00 : 0·85 : 1·92 : 2·09, which are in good agreement with the calculated figures of 1·00 : 1·00 : 2·00 : 2·00.

Conclusive proof for the structure of the pyridine nucleotide isolated from *P. chrysogenum* was provided by its identity with the nicotinic acid analogue of diphosphopyridine nucleotide prepared unambiguously from diphosphopyridine nucleotide and nicotinic acid by an exchange reaction catalysed by beef-spleen diphosphopyridine nucleotidase. This type of enzymic reaction has been utilized for the synthesis of several diphosphopyridine nucleotide analogues substituted in the pyridine moiety by pyridine

Table 1. Properties of Diphosphopyridine Nucleotide and of its Nicotinic Acid Analogue

Property	Nicotinic acid analogue of DPN	DPN*
$R_{Adenosine}$ in ethanol–1 *M* ammonium acetate, *p*H 7·5 (70 : 35, v/v)	0·23	0·26
R_P in isobutyric acid–1 *N* ammonia (100 : 60, v/v)	0·33	0·47
Relative electrophoretic mobility in 0·1 *M* ammonium acetate, *p*H 5 at 25 V./cm.	1·5	1·0
Ultra-violet absorption at *p*H 7 :		
maximum (mμ)	258	259
minimum (mμ)	230	231
$E_{max.} : E_{min.}$	2·19	2·22
$E_{250} : E_{260}$	0·86	0·83
$E_{270} : E_{260}$	0·74	0·72
$E_{290} : E_{260}$	0·28	0·22
$\varepsilon \times 10^{-3}$	18·75‡ 17·15§	18·00†
Ultra-violet absorption of cyanide complex‖		
maximum of 1st peak (mμ)	260	260
maximum of 2nd peak (mμ)	316	327
minimum (mμ)	289	289
$E_{max.}$ of 1st peak : $E_{min.}$	6·4	7·6
$E_{max.}$ of 1st peak : $E_{max.}$ of 2nd peak	3·4	2·5
$E_{250} : E_{260}$	0·75	0·85
$E_{270} : E_{260}$	0·75	0·74
$E_{290} : E_{260}$	0·30	0·27

* Spectral data for diphosphopyridine nucleotide (DPN) are taken from the literature (ref. 9).
† From Kornberg and Horecker (ref. 3).
‡ Based on ribose analysis.
§ Based on phosphate analysis.
‖ Figures for the cyanide complex of the analogue are calculated from the ultra-violet spectrum determined in 30 per cent (v/v) ethanol.

derivatives other than nicotinamide[3,4]. Anion exchange chromatography ('Dowex-1' formate, gradient elution with formic acid[4]) of the products obtained after incubation of diphosphopyridine nucleotide and nicotinic acid with the beef-spleen enzyme showed four peaks. These corresponded to the following compounds, listed in the order they emerge from the column : nicotinamide, nicotinic acid and diphosphopyridine nucleotide, the new analogue of diphosphopyridine nucleotide, and adenosine diphosphate–ribose. The analogue was eluted from the resin in the same position as the product isolated from the mould : furthermore the two compounds were indistinguishable by paper chromatography (two different solvents) and by paper electrophoresis at *p*H 5, and had identical spectral properties. The chromatographic, electrophoretic and spectral properties of the new pyridine nucleotide and of diphosphopyridine nucleotide are reported in Table 1.

The presence of a carboxyl group in the molecule of the new pyridine nucleotide increases the negative charge of the molecule, as reflected in the electrophoretic mobility of the compound, which is 1·5 times that of diphosphopyridine nucleotide, and in the previously mentioned behaviour in anion-exchange chromatography. The carboxyl group is probably responsible also for the decreased reactivity of the new compound with cyanide : in fact the rate of the reaction with cyanide was quite slow in aqueous solution, whereas in 30 per cent ethanol the peak at 316 mμ appeared very rapidly. In this respect it is interesting to note that N′-methyl-nicotinic acid (trigonellin) does not react with aqueous cyanide[6] but will react in alcoholic solution[7], in contrast to N′-methyl-nicotinamide, which reacts with aqueous cyanide[6]. These two model substances are structurally interrelated in the same way as diphosphopyridine nucleotide and its nicotinic acid analogue.

At present no data are available on the biological significance of the new pyridine nucleotide. We are now investigating its possible role as an intermediate in synthesis of diphosphopyridine nucleotide from nicotinic acid by human erythrocytes. Recently, Preiss and Handler[8] have suggested that in this process "amidation may occur after nicotinic acid is converted to some unknown nucleotide derivative".

We thank Prof. E. B. Chain for his interest in this investigation.

Note added in proof. We have now isolated from human erythrocytes incubated with nicotinic acid a compound identical with the new pyridine nucleotide from *P. chrysogenum*[10]. This shows that one of the intermediates ('compound II') found by Preiss and Handler in the synthesis of diphosphopyridine nucleotide from nicotinic acid in human erythrocytes[11] is, in fact, the nicotinic acid analogue of diphosphopyridine nucleotide, that is, desamido-diphosphopyridine nucleotide, as they suggested.

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Fungistatic Activity of some Hydroxamic Acids

It was found by two of us[1] that salicylhydroxamic acid completely inhibits growth of some pathogenic fungi (*Trichophyton schoenleinii*, *T. gypseum*, *T. rubrum*, *T. violaceum*) *in vitro* at a concentration of 0·025–0·1 per cent (0·25–1·0 mgm. per 1 ml.). A similar effect was produced by benzohydroxamic acid and 2-hydroxy-3-naphthydroxamic acid[2]. It was interesting to find that 5-bromosalicylhydroxamic acid ("T 40")[3] (which has now found clinical application in Poland as an auxiliary remedy in treating tuberculosis in addition to 'INH'[4]) possesses a very low fungistatic activity.

Salicylhydroxamic acid, which formerly was found to be of low toxicity[5], was clinically examined at the Municipal Hospital No. 1 in Poznan. From the beginning of 1956 to the middle of 1957 twenty-one cases of trichophytiasis and one case of epidermophytiasis were examined. Salicylhydroxamic acid was given *per os* during 10 days in doses 1 gm. and 0·5 gm. daily to adults and children, respectively. Quick healing followed, which in many cases was very spectacular. Simultaneously, systematic investigation of blood and urine of patients did not show any unfavourable effect due to the treatment. Salicylhydroxamic acid might therefore be a possible remedy against diseases produced by pathogenic fungi. Detailed description of clinical experiments will be published by one of us (J. A.) elsewhere.

Another line of research consisted in preparing a number of derivatives of phenoxyacethydroxamic acid and determining their fungistatic activity against *Fusarium culmorum*, *Alternaria solani* and *Rhizoctonia solani*[6]. Chlor-derivatives of phenoxyacethydroxamic acid proved to exert a particularly strong fungistatic activity *in vitro*.

Thus 4-chloro-2-methylphenoxyacethydroxamic acid was effective against *F. culmorum* at a concentration 0·005 per cent in solid agar culture medium. 2,4-Dichlorophenoxyacethydroxamic acid was effective against all three fungi examined at concentration 0·025 per cent. Similar activity was shown by 3,4-, 2,5-di- and 2,4,6-trichloro-derivatives.

The same group of compounds was examined against pathogenic fungi. 3,4-Dichlorophenoxyacethydroxamic acid was found to be particularly effective not only against *Trichophyton* but also against various pathogenic yeasts. It completely inhibited growth of *Candida albicans*, *C. krusei*, *C. tropicalis*, *Cryptococcus neoformans*, *Geotrichum 1* and *Geotrichum malatensis 53* when used in concentration 0·003–0·025 per cent in liquid Sabouraud medium.

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Ethyl-3-Indoleacetate : an Artefact in Extracts of Immature Corn Kernels

The isolation and identification of 3-indoleacetic acid in corn kernels has been well established[1]. While characterization of ethyl-3-indoleacetate in ethanol extracts of corn kernels, *Zea mays*, variety Golden Cross, has been reported from this laboratory[2], it has been suggested that ethanol extraction may have resulted in the formation of an artefact[3].

To avoid esterification, peroxide-free ethyl ether was used as the extractant in the present study. Freshly harvested, immature (early milk stage) corn kernels, variety Golden Cross, were covered with ethyl ether and extracted for two hours at 2° C. ('free auxin' or first fraction). Additional cold ethyl ether washings of the kernels were added to the original extract. The kernels were again covered with ethyl ether and extracted for 48 hr. at 25° C. ('bound auxin' or second fraction). The first and second ethyl ether fractions were further separated into acidic and non-acidic ('neutral') portions by extraction with 5 per cent aqueous sodium bicarbonate. The bicarbonate solution containing the acidic substances was adjusted to *p*H 2·8 with hydrochloric acid and extracted with ethyl ether. The aqueous layer was discarded, and the acidic substances in the ether layer were retained. Acidic and non-acidic ethereal solutions were separately concentrated under reduced pressure with the bath temperature kept below 25° C. The constituents of the concentrated extracts were partitioned by paper chromatographic techniques (Whatman No. 1 filter paper, solvent mixture 2-PrOH : NH_3 : H_2O (8 : 1 : 1 v/v)[4]) and their biological activities assayed[5].

3-Indoleacetic acid was detected in the chromatographically separated acid fractions through biological assays, by development of characteristic colours with Salkowski and Ehrlich spray reagents, and ultra-violet absorption spectra. In addition, growth-promoting zones with R_F 0·25–0·33 and growth-inhibiting zones with R_F 0·60–0·70 were noted in both acid fractions. A similar observation of growth-stimulating and -inhibiting zones has been reported for absolute ethanol extracts of corn kernels (ref. 1, Kefford).

Growth-stimulating zones of R_F 0·80–0·90 were observed in histograms of neutral fractions. The R_F values were similar to those reported for ethyl-3-indoleacetate and 3-indoleacetonitrile; however, the presence of an indole moiety could not be established by ultra-violet absorption spectra or by the reactions to Salkowski and Ehrlich colour reagents. Absence of ethyl-3-indole-acetate in the ethyl ether extracts of corn kernels, *Zea mays*, variety Golden Cross, indicated that it was previously isolated as an artefact[3]. The characterization of this neutral growth substance is now in progress, and a more detailed report will be published elsewhere.

We are indebted to Dr. F. G. Teubner for his interest and suggestions throughout this investigation.

This work was supported in part by the National Science Foundation, Washington, D.C.

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Actinomycete Disintegration of Raw Wool

During the course of investigations on bacterial disintegration of raw wool, the presence of Actinomycetes in rotted wool was often noted. These organisms, however, rarely appeared in culture, perhaps because of the prevalence of *Pseudomonas aeruginosa* the antagonistic effects of which are well known. Eventually Actinomycetes were isolated

from nutrient agar cultures of at least one month's growth when these had been left to dry out at room temperature. Under these conditions aerial hyphæ appeared, from which pure cultures of the organisms were obtained.

A number of Actinomycetes have been isolated from the living fleece and from fleece wool, all of which are capable of bringing about a rapid disintegration of raw wool fibres, both under laboratory conditions and when inoculated into the living fleece. These organisms readily attack autoclaved wool as well as wool which has not been sterilized, when this is maintained at high humidity. The inoculated wool fibres become chalky-white and tend to clump together at the areas of inoculation. When examined microscopically these areas show extensive fibre disintegration, such as severed fibres with 'brush ends', free cuticular scales and individual fusiform cortical cells.

Actinomycetes have been mentioned previously by other workers as active agents in the disintegration of processed wool[1]; but the present observation of their degrading effects on raw wool and their mode of attack are of interest. It has been observed repeatedly that Actinomycete threads ramify freely within the wool fibre between the cuticular scales and the cortical layer below them. Entry by the Actinomycete is frequently by penetration between cuticular scales, and observations suggest that it may also be through the actual scale surface. Fibres from inoculated wool were observed with quite extensive internal Actinomycete growth before damage to the fibre was apparent. Severe disintegration under laboratory conditions may be brought about in 3–4 days by holding inoculated wool at 37° C. in high humidity. It has been demonstrated[2] that the hyphæ of the ringworm fungus *Microsporum gypseum* are able to penetrate the wool fibres of degraded cloth and grow parallel to the fibre axis, bringing about a disintegration similar to that effected by the Actinomycetes here described.

The fleece has been shown to contain fibre types[3] differing in plasticity and amorphous/crystalline ratio[4]. In order to determine whether these fibre types were attacked differentially, a sample of Romney lamb's wool was sorted according to type of fibre into six groups, and these, together with a sample of human hair, were placed in cavity slides to which a few drops of a nutrient broth culture of one of the most active of these Actinomycetes was added. These were maintained aseptically under humid conditions at 37° C. After two days, damage to fibres and to the human hair was evident on microscopic examination, and after seven days all six types of wool fibres became characteristically opaque and showed severe to very severe disintegration. Human hair was extensively degraded, showing brush ends, fractures and free cortical cells, but the damage was not as severe as that brought about in the wool fibres.

The effect of Actinomycetes isolated from soil from a sheep paddock was investigated by inoculating these on to wool samples maintained in a humidity chamber at 30° C. These soil isolates brought about varying degrees of fibre degradation. After six days, three of the seven isolates brought about well-advanced disintegration, two had penetrated the wool fibres without causing visible damage, and two had neither damaged nor penetrated the wool fibre.

This work was undertaken with financial assistance from the Department for Scientific and Industrial Research, New Zealand.

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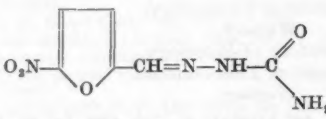
Site of Reduction of Nitrofurazone by Bacteria

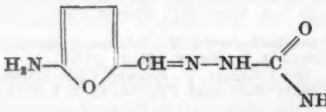
Antibacterial nitrofurans are reduced to the corresponding amino-compounds by *Aerobacter aerogenes*[1]. The site of the reaction (in a different organism) is now shown to be the cytoplasmic membrane rather than the cell wall or cytoplasm. Lack of an enzyme system capable of effecting this reaction in the bacterial cell walls was not unexpected[2].

Attempts to obtain isolated protoplasts from *A. aerogenes* were unsuccessful. However, *Bacillus megaterium*, strain *KM*, reduced nitrofurazone (5-nitro-2-furaldehyde semicarbazone, I) in 0·04 *M* phosphate buffer (*p*H 7·0) in presence and absence of 0·2 *M* sucrose;



(I)

the ultra-violet absorption pattern observed after drug-bacteria contact was identical with that previously obtained using *A. aerogenes*, indicating reduction to 5-amino-2-furaldehyde semicarbazone (II)[1].



(II)

Protoplasts, obtained by lysozyme digestion of *B. megaterium* in the above buffer with sucrose as stabilizer[3], also reduced nitrofurazone but at a slower rate than that observed for the whole cells. Centrifuging the protoplasts, to allow removal of the digestion medium, and careful re-suspension in the phosphate–sucrose solution further decreased the rate of reduction of nitrofurazone. The difference in rates probably indicates damage to the fragile protoplasts.

Lysis of the protoplasts by osmotic shock (resuspension of centrifuged protoplasts in buffer only) or lysozyme digestion of whole cells in absence of a stabilizer both yielded preparations incapable of reducing nitrofurazone. McQuillen[4] previously reported some synthetic ability in suspensions of protoplasts which had been lysed by shaking in a stabilizing medium. A similar preparation from *B. megaterium* showed slight ability to reduce nitrofurazone, but 'Anoptral' contrast microscopy revealed the presence of a small proportion of unbroken protoplasts which may well account for the observed reduction. Isolated

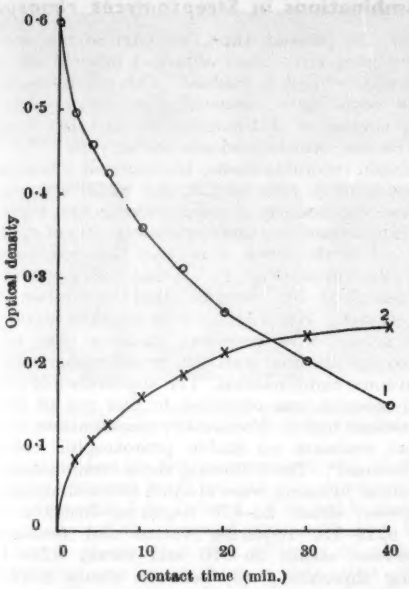


Fig. 1. Changes in the ultra-violet absorption of solutions of nitrofurazone (initially 10 μgm. per ml.) after varying times of contact with *B. megaterium* (optical density of suspension *c.* 0·4 at 500 mμ in a 1-cm. cuvette) in presence of buffer and sucrose. Curve 1, loss of nitrofurazone (λmax. 375 mμ), as indicated by the optical density at 400 mμ; curve 2, optical density (corrected for absorption due to unchanged nitrofurazone) at 333 mμ, the absorption maximum of 5-amino-2-furaldehyde semicarbazone

cell walls, prepared by the method of Salton and Horne[5], failed to reduce nitrofurazone.

The rate of reduction of nitrofurazone by whole bacteria was rapid and proceeded with no detectable lag (Fig. 1); loss of the 375 mμ absorption peak of the drug was accompanied by an increase in absorption and subsequent development of a peak at 333 mμ due to 5-amino-2-furaldehyde semicarbazone. The speed of this reaction indicated that it occurred at the surface of the bacterial cell. The concept of the cell wall as a rigid but open structure freely permeable to ions and molecules of low molecular weight is currently accepted. Such a cell wall, apparently devoid of enzyme systems, would allow free passage of both nitrofurazone and its corresponding amino-derivative. No loss of nitrofurazone due to adsorption by whole cells or cellular fragments occurred.

The results indicate that the enzyme system responsible for the reduction of nitrofurazone is probably located on the surface of the intact protoplasts. In the absence of added co-factors, all ability of the protoplasts of *B. megaterium* to reduce nitrofurazone is lost upon disorganization of the cytoplasmic membrane; presumably reduction is dependent upon correct orientation of drug, enzyme(s) and co-factor(s) in sufficient concentrations upon the membrane. Disorganization of the latter results in denaturation of the enzyme, or separation, or incorrect alignment of the various components.

Asnis[6] has shown, however, that cell-free extracts of *Escherichia coli* are capable of reducing nitrofurazone upon addition of diphosphopyridine nucleotide and an oxidizable substrate. His results indicate the possibility that the nitrofurazone reducing enzyme(s) are located in the contents of the cell. However, cell disorganization may have liberated the enzymes from association with the cytoplasmic membrane, and the added materials may be present in relation to the enzyme systems in concentrations completely different from those obtaining in the intact organism. These results do not therefore invalidate the above arguments.

A detailed account of this and related work will be published elsewhere.

We thank Dr. M. R. J. Salton for a culture of *B. megaterium* and Smith, Kline and French Laboratories, Ltd., for a gift of nitrofurazone.

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Reversal of Boric Acid Inhibition of Growth in Certain Soil Micro-organisms

An investigation has been made concerning the degree to which various concentrations of boric acid inhibit the growth of three soil micro-organisms and the extent to which this inhibition may be reversed.

Boric acid has been reported to inhibit the growth of *Micrococcus pyogenes* var. *albus*, *Streptococcus* sp. *beta-haemolyticus*, and *Diplococcus pneumoniae* at concentrations of 0·5, 2·0, and 1·0 per cent respectively[1]. Boric acid at a concentration of 0·25 per cent reduced the growth of *Escherichia coli*, and a concentration of 0·5 per cent produced marked bactericidal action[2]. Tyner[3] found no bacterial growth in soil samples grown on plates containing boric acid when the concentration of the acid was 0·18 per cent or higher.

The current study was concerned with determining the lowest concentration of boric acid required to reduce the growth of the organisms under study, the differentiation of boron effect from a *p*H effect, and the feasibility of reversing the effects of boric acid.

Azotobacter chroococcum (A.T.C.C. 4412) and *Rhizobium meliloti* (A.T.C.C. 10312) were grown in media containing extracts of African violet soil plus 2 and 1 per cent mannitol respectively. *Streptomyces* sp. (A.T.C.C. 11238) was grown in Czapek's medium. The addition of increasing amounts of boric acid to the media yielded increasingly acid solutions. In the cases of *A. chroococcum* and *R. meliloti*, a *p*H lower than that of an equivalent solution of pure boric acid was obtained due to the interaction of the boric acid with mannitol.

Reduction in the growth of *R. meliloti* occurred at a boric acid concentration of 0·06 per cent; the medium had a *p*H of 5·2. *A. chroococcum* evidenced reduced growth at a boric acid concentration of 0·12 per cent; the *p*H of this medium was 5·6. In both cases the organisms showed reduced growth in media the acidity of which was such that the reduced growth would have been expected even in the absence of a specific boron effect.

Table 1. Growth at Various Boron-Levels

Boric acid (per cent)	*Rhizobium meliloti* A.T.C.C. 10,312	*Azotobacter chroococcum* A.T.C.C. 4,412	*Streptomyces* sp. A.T.C.C. 11,238
0	+++	+++	++
0·02	+++	++	++
0·04	+++	++	++
0·06	+++	++	+
0·08	+++	++	+
0·12	+++	++	±
0·16	+	++	−
0·32	±	±	−
0·40	±	±	−

Table 2. Effect of Mannitol on the Growth of Borate-inhibited *R. meliloti*

Boric acid (per cent)	Mannitol (per cent)					
	1	2	3	4	6	8
0	+++	+++	+++	+++	+++	+++
0·12	+++	+++	+++			
0·16	+	++	++	++	++	++
0·32	±			++	++	++
0·40	±			++	++	++

In order to delineate the toxic effect of boron from the *p*H effect, the organisms were grown in media adjusted to *p*H 7·0–7·8 after the addition of the requisite amounts of boric acid. Under these conditions considerably larger amounts of boric acid were needed to inhibit the growth of the organisms (Table 1). The growth of *Streptomyces* sp. is reduced at 0·06 per cent, that of *R. meliloti* at 0·16 per cent, and of *A. chroococcum* at 0·32 per cent boric acid.

In an attempt to reverse the boric acid effect on *R. meliloti*, the media was supplemented with increasing amounts of mannitol. The results shown in Table 2 were obtained. Good growth of this organism could be obtained at levels of boric acid which had previously been shown completely to inhibit its growth. However, the experiments do not show whether the observed reversal of inhibition is accomplished through an extracellular sequestering of borate by mannitol or through intracellular competition for the boron.

Roush and Norris found that borate inhibited the action of the enzyme xanthine oxidase[4]. This inhibition is presumably brought about by the complexing of borate with the *cis*-hydroxyl groups on the ribose moiety of the riboflavin coenzyme. The inhibition produced by 0·032 *M* borate was completely reversed by the addition of a slight excess of sorbitol (0·04 *M*). Four times as much glucose on a molar basis, 0·128 *M*, was required to reduce the borate inhibition from approximately 50 to 15 per cent.

In the current studies with *R. meliloti* the inhibition of growth resulting from the addition of 0·026 *M* boric acid could be reversed by 0·11 *M* mannitol, whereas poor growth resulted in the medium containing 0·055 *M* mannitol. Additionally, the inhibition observed when 0·052 *M* boric acid was added was not at all alleviated by the addition of 0·22 *M* glucose.

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Recombinations in *Streptomyces rimosus*

Up to the present time, recombinations among Actinomycetes have been obtained only in *Streptomyces coelicolor*[1] and *S. fradiae*[2]. This communication presents some data concerning recombinations in another species of Actinomycetes, namely, *Streptomyces rimosus*, which produces terramycin.

To obtain recombinations, biochemical mutants of two strains of *S. rimosus* (2*a* and 8229) were used. When two biochemical mutants were grown together on a complete medium there appeared tufts of exuberant growth in the zones of contact between colonies of the two types (Fig. 1). These tufts resembled those described by Sermonti and Spada-Sermonti in *S. coelicolor*[1]. When spores from a mixed seven-day culture grown on a complete medium were transferred to the minimal medium, prototrophic colonies arose in some combinations. The appearance of prototrophic colonies was observed in five out of fifteen combinations tested. From other combinations of biochemical mutants no stable prototrophic colonies were obtained[3]. The following three combinations of biochemical mutants were studied more thoroughly: (1) between strain 2*a*–870 requiring histidine and strain 8229–310 requiring valine and *iso*leucine; (2) between strain 2*a*–870 and strain 8229–1361 requiring threonine; (3) between strain 8229–310 and strain 8229–1361. The frequency of prototrophic colonies from these combinations is presented in Table 1.

Table 1. Frequency of Prototrophic Colonies derived from Mixed and Separate Growth of Biochemical Mutants

Spores derived from	No. of spores plated on minimal medium	No. of prototrophic colonies	Frequency of prototrophs
2*a*–870	$3·9 \times 10^7$	0	0
8229–310	$5·2 \times 10^7$	0	0
8229–1361	$3·7 \times 10^7$	0	0
2*a*–870 + 8229–310	$4·0 \times 10^7$	122	3×10^{-6}
2*a*–870 + 8229–1361	$6·4 \times 10^8$	391	6×10^{-5}
8229–310 + 8229–1361	$7·2 \times 10^7$	31	4×10^{-7}

In all three combinations of the biochemical mutants there appeared several types of prototrophic colonies differing from each other by their morphological characters and antibacterial activity. Fig. 2 shows the colonies of the parental types and of the three types of prototrophs from the combination 2*a*–870 + 8229–310. As it is evident from the photographs, two types of prototrophs produced well-sporulating colonies in contrast to the both parental types.

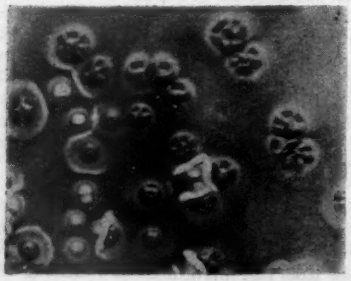

Fig. 1. Tufts between colonies of two biochemical mutants

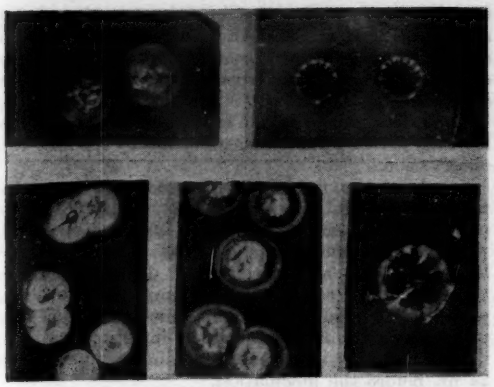

Fig. 2. Parental types (above) and three types of prototrophs (below) from the combination 2*a*–870 + 8229–310

The comparative antibacterial activity of the biochemical mutants and prototrophs developed from them is presented in Table 2. This table also shows the activity of the original strains 2*a* and 8229.

Table 2 shows that the activity of almost all prototrophs was much higher than that of their parents. The activity of some types of prototrophs reached, and even exceeded, that of the original strains.

Special experiments were carried out to study the stability of the prototrophic colonies on successive transfers. It was observed that two types of the prototrophs from the combination 8229–310 + 8229–1361 regularly produced auxotrophic segregants in several generations. The frequency of their appearance was 3–4 per cent. Just like one of their ancestors (8229–1361), all auxotrophic segregants required threonine. Auxotrophs similar to the other ancestor (8229–310), that is, auxotrophs requiring valine and *iso*leucine, were not detected. It should be noted that auxotrophs requiring threonine differed morphologically from the corresponding biochemical mutant. The auxotrophs arising from one type of prototrophs morphologically differed from the auxotrophs arising from the other type.

The results presented indicate a great similarity between the recombination processes in *Streptomyces coelicolor* and *S. rimosus*. In both species the development of prototrophic colonies was not observed in every combination of biochemical mutants. Likewise the development of auxotrophic segregants from the spores of prototrophs was not regular in both species[1,4]. However, there are some differences between these two species. For example, in *Streptomyces coelicolor* all combinations of biochemical mutants tested produced only one type of prototrophic colonies, whereas in *S. rimosus* several types of prototrophic colonies appeared.

Table 2. Comparative Antibacterial Activity of the Original Strains, their Biochemical Mutants and Prototrophs

Strains	Antibacterial activity (units/ml.)
Original strains	
8229	1,429
2*a*	1,234
Biochemical mutants	
8229–1361	262
8229–310	97
2*a*–870	28
Prototrophs from combination 2*a*–870 + 8229–310	
Type I	705
Type II	1,622
Type III	1,555
Prototrophs from combination 2*a*–870 + 8229–1361	
Type I	663
Type II	281
Type III	1,269

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A Haploid Plant of the Potato Variety Katahdin

A plant with a somatic chromosome number of 24 was found among an F_1 population of a cross between the tetraploid *Solanum tuberosum* variety Katahdin and the cultivated South American diploid species *Solanum rybinii*. This plant resembles the female parent Katahdin and lacks any of the distinctive characters of the male parent *S. rybinii*. It is therefore presumed to be a haploid plant of Katahdin which arose through parthenogenesis.

Fig. 1. Plants of haploid (right) and triploid F_1 hybrid

The haploid of Katahdin is a thrifty plant, but its rate of growth is considerably slower than the triploid F_1 *S. tuberosum* × *S. rybinii* hybrids. Much of the marked difference in height between the F_1 hybrid and the haploid is due to the short internodes of the latter (Fig. 1). Mature leaves of the haploid are smaller than comparable leaves of the F_1 plants and of the variety Katahdin (Fig. 2, Table 1). The

Table 1

Plant	Chromosome number (2*n*)	Mean terminal leaflet width–length (mm.)	Mean stomatal length (μ)
Haploid	24	53–81	31
F_1 hybrid	36	71–99	38
S. tuberosum var. Katahdin	48	84–110	43

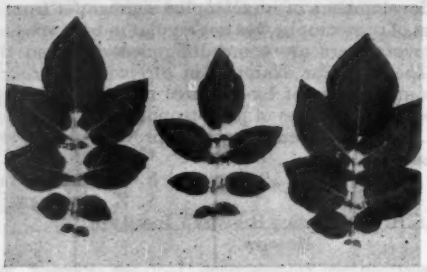

Fig. 2. Mature leaves (left to right) of triploid F_1 hybrid, haploid and Katahdin

stomata of the haploid are smaller than those of Katahdin and of the F_1 hybrids (Table 1).

Haploid plants of the tuber-bearing *Solanum* species have been described previously. Several haploid plants ($2n = 36$) of the late blight-resistant Mexican hexaploid, *S. demissum* ($2n = 72$) have been reported (Bains and Howard[1], Dodds[2] and Hougas unpublished). Ivanovskaja[3] reported a haploid plant ($2n = 24$) of *S. tuberosum* variety Aurora from pollination of the cultivated potato Aurora with pollen of *S. rybinii*. One of the twin seedlings in the progeny of a tetraploid F_1 interspecific hybrid (*S. chaucha* × *S. tuberosum*) was found by Lamm[4] to be a haploid ($2n = 24$). A single germinable seed resulting from the pollination of the Mexican tetraploid *S. polytrichon* with the Mexican tetraploid *S. stoloniferum* produced a haploid plant ($2n = 24$) of *S. polytrichon*[5].

The significance of haploids as tools for experimental research in cytogenetics and genetics as well as for breeding has been recognized in other crops such as corn and cotton[6]. Similar researches with the *Solanum* species would appear equally promising.

The haploid of Katahdin has not flowered yet. Studies of meiosis, pollen fertility and seed set will be reported later.

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Leptospira Antibody Production by Bovine Fœtuses

It is commonly stated that calves are born without γ-globulin and that the bovine fœtus is unable to produce antibodies. The first part of the statement is invalidated by the detection of measurable amounts of γ-globulin in pre-colostral serum of new-born calves[1-3]. The question whether this globulin has been developed by the calf or passively acquired *in utero* was left open by Pierce[3]. Little and Orcutt[4] found *Brucella* agglutinins in pre-colostral serum of a premature *Brucella*-infected calf and in serum of aborted fœtuses from *Brucella*-infected cattle, but expressed no opinion about the origin of these antibodies.

The ability of the bovine fœtus to develop immunologically active γ-globulin is indicated by the following observation.

5 ml. of a cotton-filtered guinea pig liver suspension, containing approximately 2×10^3 guinea pig infective doses of *Leptospira saxkoebing* per ml., were injected into a placentome in each of two laparotomized cows on the 214th day (cow 39) and the 223rd day (cow 41) of pregnancy. In order to prevent maternal leptospirosis, the dams had been passively immunized against the infecting strain by the intravenous injection of bovine immune serum 24 hr. before the inoculation.

The dams were only slightly affected by the operation. Cow 39 gave birth to a calf on the 261st day of pregnancy (that is, 47 days after the inoculation) and cow 41 to twin calves on the 264th day of pregnancy (that is, 41 days after the inoculation). The membranes were expelled in both cases within 8 hr. after birth; the cotyledons appeared normal except for three uniformly necrotic cotyledons in the membranes of calf 39.

The three calves were smaller and less vigorous than normal calves, but developed normally until killed when nine (calf 39) and seven (calves 41 *A* and *B*) days old. Necropsy of the calves showed no gross lesions, but histological examination revealed small interstitial cell infiltrations in the renal cortex and in the periportal tissue of all three calves. The infiltrating cells were predominantly histiocytes, with some eosinophilic leucocytes and cells resembling lymphocytes. These findings could be explained as results of a fœtal leptospirosis. However, leptospiræ could not be demonstrated in the kidneys by impregnation *ad modum* Levaditi or by cultivation in Korthof's medium.

The results of agglutinin–lysin titrations against *L. saxkoebing* are given in Table 1. As the titres of pre-colostral sera from the calves greatly exceeded those of the dams at any time during the experimental period, it is highly improbable that the antibodies found in the unfed calves were transferred from the dams. Moreover, the steadily rising titres of the calves suggest that already at birth the calves were in a state of antibody production.

Electrophoresis on paper (kindly performed by A. Birch-Andersen, Statens Seruminstitut, Copenhagen) disclosed the presence of small amounts of γ-globulin in all three pre-colostral calf sera. Agglutinin–lysin titration of eluates of the various protein fractions

Table 1. Agglutinin–Lysin Titres against *L. saxkoebing* of Sera from the Experimental Cows and their Calves and of Colostral Whey

Specimen tested	Days after inoculation	Cow 39 and calf	Days after inoculation	Cow 41 and calves *A* and *B*	
Dam's serum	0	400	0	400	
	24	20	24	40	
	47*	0†	41*	20	
Colostral whey	47	10	41	10‡	
Calf's serum	47	6,400§	41	6,400§	6,400§
	49	6,400	43	12,800	12,800
	56	12,800	48	25,600	25,600

* Day of parturition. † Less than 10. ‡ Second milking (sample of first milking not available); § Before ingestion of colostrum.

Table 2. AGGLUTININ–LYSIN TITRES AGAINST *L. saxkoebing* OF ELUATES OF ELECTROPHORETIC PROTEIN FRACTIONS OF PRE-COLOSTRAL CALF SERA

Serum from	Albumin	α-glob.	β-glob.	γ_1-glob.	γ_2-glob.
Calf 39	0*	0	8	32	2
Calf 41 *A*	0	0	4	32	4
Calf 41 *B*	0	2	16	64	4

* Less than 2.

showed the antibody activity to be associated mainly with the γ_1-globulin fraction, as shown in Table 2.

It is concluded that the three calves examined had developed immunologically active γ-globulin *in utero* in response to fœtal infection with *Leptospira saxkoebing*.

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Fractionation of Human Erythrocytes on the Basis of their Age

HUMAN erythrocytes have a life-span in the circulation of approximately 120 days[1]. They are incapable of cell division and consequently leave no progeny. These characteristics make them attractive subjects for the study of biochemical changes incident to normal maturation and senescence, assuming it were possible to separate them into groups of old, middle-aged, and young cells without the use of artificial hæmatopoietic stimuli[2]. This communication presents a method of red cell fractionation which complies with these criteria.

$^{59}FeSO_4$ was administered intravenously to four normal human subjects. At intervals during the succeeding 140 days, venous blood, drawn into heparin, was subjected to so-called serial osmotic hæmolysis as follows. A 2·5-ml. aliquot of fresh erythrocytes was washed three times in 0·85 per cent sodium chloride and then exposed to 5 ml. of unbuffered saline, varying in concentration from 0·41–0·38 per cent, which was previously determined to produce about 2 per cent hæmolysis. After centrifugation the supernatant hæmolysate was removed and the residual cells treated with saline of lower concentration. This process was repeated 8–12 times, until hæmolysis of the initial aliquot of blood was complete. After the hæmolysates were cleared by centrifugation, hæmoglobin concentrations were determined by the cyan–methæmoglobin method[3], and the radioactivity assays were performed. From such data and the known volume of each hæmolysate the percentage of cells represented by individual fractions and the corresponding specific radioactivity were calculated.

This procedure differs from the conventional method of osmotic hæmolysis[4] in that all fractions are derived from a single aliquot of blood, and cumulative effects resulting from superimposition of one fraction on another are eliminated.

Fig. 1*A* represents specific radioactivity versus fragility data obtained in a typical subject 3 days after intravenous administration of iron-59, at a time when only young cells are tagged[5]. Ostensibly there are two varieties of young cells, and they are found at extreme and opposite ends of the fragility scale. In subsequent investigations we assumed that the initial small peak represented an artefact, and attempted to demonstrate this. It was felt that *in vitro* exposure of the cells during the interval between venepuncture and recovery of the first fraction or the unique proximity of white cells to the younger red cells residing at the top of the centrifuged column of blood[6] might traumatize some of the young erythrocytes. However, neither preincubation at room temperature or at 37° C. for 1–4 hr., nor removal of at least 80 per cent of the leucocytes altered the pattern depicted in Fig. 1*A*. In addition, leakage of non-hæmoglobin iron as a possible source of radioactivity in the first fraction was eliminated by the observation that washing with either isotonic or hypotonic saline did not result in any loss of activity from the cells. It should be noted that these fractionations were carried out at room temperature (21–23° C.). Fractionations performed at 37° C. produced essentially similar results, whereas no consistent pattern could be obtained at 4° C.

In the light of the failure to ascribe this double-peaked pattern to a methodological artefact, our present interpretation is that normal blood may contain two populations of young red cells which are separable on the basis of the parameter here studied, namely, serial osmotic fragility. A short-lived population of red cells in normal individuals has been postulated[7,8]. However, we have no information relating to the life-spans of the two populations described above.

It has been estimated that 80–98 per cent of the cells three days old or younger are represented in the terminal peak. It has also been calculated, on the basis of ten experiments, that more than 50 per cent of all the cells represented in a terminal 5 per cent fraction are derived from such young cells. Similarly, it has been estimated that 1·5–10 per cent of the cells three days old or younger are represented in the initial peak and that only about 2·5 per cent of all the cells in an initial 2 per cent fraction are derived from such young cells. These values are only approximations since they are based on the assumption that the distribution of counts per tagged cell is similar in both peaks.

This pattern gradually gives rise to the pattern depicted in Fig. 1*B*, which is representative of specific radioactivity versus fragility data obtained about two months after the administration of the radioactive isotope. It will be noted that the terminal fraction has a specific radioactivity only about half as great as the large middle fraction. This is consistent with the earlier calculation that about 50 per cent of the cells in a terminal 5 per cent fraction are derived from cells ranging in age from 1 to 3 days, the tracer content of these cells now being very low. In addition, Fig. 1*B* demonstrates that the initial fractions are also impoverished with respect to middle-aged cells. In so far as it has been shown that only a very few per cent of the erythrocytes herein represented are derived from young cells, it follows that this fraction is enriched with respect to cells older than two months.

By the end of the third month the specific activities of the initial fractions increase while those of the terminal fractions remain low.

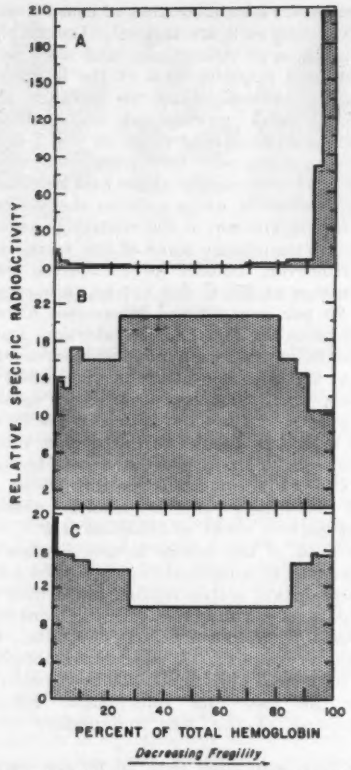

Fig. 1. Serial osmotic hæmolysis at room temperature (21–23° C.) *A*, 3 days; *B*, 57 days; *C*, 115 days after the intravenous administration of iron-59. Relative specific activity is defined as counts per min. per unit amount of hæmoglobin compared with a number assigned to represent the specific radioactivity of the least-active fraction

A new pattern evolves toward the end of the fourth month as illustrated by a typical curve obtained 115 days after the administration of iron-59 (Fig. 1*C*). It is of interest to contrast this pattern with the one depicted in Fig. 1*A*. Thus, whereas within the first few days following labelling the terminal peak was twenty times greater, on the average, than the initial peak, now, in this late stage of the experiment the initial peak is as great as or greater than the terminal one. These results indicate that cells older than 100 days of age tend to be concentrated in the most fragile fraction. The terminal peak is presumably a result of the re-utilization of iron-59. Confirmation of this interpretation was obtained by fractionating red cells obtained from a subject who, 99 days earlier, had received a transfusion of normal chromium-51 labelled blood. Since chromium-51 is not re-utilized by erythrocytes[9], all cells containing tracer at the time of fractionation were older than 99 days. Data obtained revealed a sharp specific radioactivity peak in the most fragile fraction with rapid decrease in specific radioactivity thereafter. Recently, results have been reported relating to the centrifugal separation of human erythrocytes as a function of cell age[10]. The authors' conclusion, that the bottom layer contains the cells of oldest mean cell age, does not appear entirely compatible with the chronological appearance of maximal specific radioactivity in this layer.

The present results demonstrate that by the use of serial osmotic hæmolysis human erythrocytes can be resolved, to a significant extent, into fractions enriched with respect to old, middle-aged, or young cells. In addition, evidence has been adduced which suggests that normal blood may contain two populations of young red cells.

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Chromsoome Number in the Sugar-Beet Nematode *Heterodera schachtii* Schmidt

Mulvey[1] made a preliminary study of oogenesis in a species of *Heterodera* (probably *H. schachtii* var. *trifolii* Goffart, 1932) from the roots of hairy vetch (*Vicia villosa* Roth), this being the first record of oogenesis in a cyst-forming nematode. This is a report on the chromosome number and arrangement during meiosis of the sugar-beet nematode, *H. schachtii* Schmidt, 1871.

As the males are numerous, this nematode is evidently bisexual and has normal oogenesis, that is, two polar bodies are produced and the diploid number of chromosomes is reduced during maturation. Living white gravid females (both monocyst and mass cultures) taken from the roots of rutabaga, cabbage and red beet plants were prepared for study by the squash technique[2]. The material was fixed in an iron–mordant fixative[3] to which a few drops of propionic–orcein stain was added. Squash preparations were then prepared in the normal manner. By

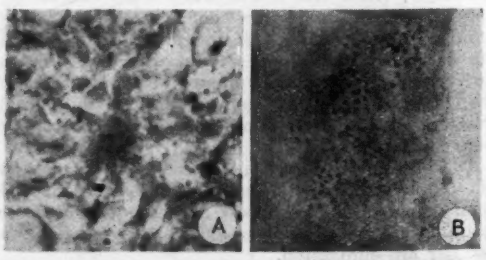

Fig. 1. *A*, Metaphase I, in *H. schachtii*, showing nine bivalents (× 1,500); *B*, small, tailless sperm in the spermatheca (× 1,080)

this method the chromosomes were stained intensely and were easily photographed.

Nine bivalents are regularly formed at meiosis (Fig. 1*A*). The chromosomes are very small, and at metaphase I of meiosis the largest bivalent is about 1 micron long. Mitotic divisions in the anterior part of the ovary show discrete chromosomes which are extremely small and difficult to count.

The well-developed spermathecæ are usually amply supplied with small, tailless sperm (Fig. 1*B*).

The many oocytes examined showed few did not contain sperm, but only one sperm was observed in each oocyte.

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Chromosome Number in the Ferret (*Putorius furo*)

THE testes of two male ferrets were teased in distilled water, where they remained for about 10 min., and then the pieces were put into aceto-orcein and temporary slides were made by the usual squash method.

The testicular materials under observation provided numerous spermatogonial cells undergoing division. Chromosome counts were made from those cells only that seemed to be intact and had the chromosomes well spread. From the mitotic metaphase plates it was clearly seen that the diploid chromosome number was 40 (Fig. 1 (1)).

Fig. 1. Chromosomes of the ferret (× 1,350): (1) mitotic metaphase with 40 chromosomes; (2) first meiotic metaphase with 20 bivalents

The primary spermatocyte divisions contained 20 bivalent chromosomes (Fig. 1 (2)). Thus the first meiotic metaphase showed 19 ordinary bivalents and one element with a heteromorphic structure which was thought to be the *XY*-complex.

That the haploid chromosome number was 20, was also confirmed from counts of second meiotic metaphase chromosomes.

The results obtained in this investigation indicate that the diploid chromosome number in the male ferret (*Putorius furo*) is 40 and not 34 as previously reported by Koller[1], who made his cytological observations on sectioned testes material.

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Paravortex scrobiculariae (Graff) in Great Britain

THE genus *Paravortex* was established by Wahl[1] for a vorticid Rhabdocoele living in the intestine of the lamellibranch *Scrobicularia plana*. Three species are now recognized with some certainty, all associated with bivalve molluscs. *Paravortex* (= *Graffilla*) *gemellipara* (Linton) lives as a commensal in the mantle cavity of the American ribbed mussel, *Modiolus demissus*[2,3]; *P. cardii* Hallez in the stomach of the common cockle *Cardium edule*[4] and *P. scrobiculariae* (Graff) in the intestine, and occasionally also in the stomach, of *Scrobicularia plana*. All three species are viviparous, the eggs developing in thin-walled capsules embedded in the mesenchyme of the mother. The embryos escape by passing across the maternal tissues, and, after a short free-living period, reinfect another, or perhaps the same, host.

The two European species were distinguished morphologically by Hallez[5]. *P. cardii* is yellow-white in colour, attains a maximum length of 1 mm., the genital pore is situated one-quarter of the body-length from the anterior end, the ovaries are corniculate, and the embryos on hatching have a length of 0·088 mm. The adult lives in the stomach of *Cardium*, and only young stages are found in the intestine, attaining a length of 0·35–0·40 mm. before being discharged through the exhalant siphon. *P. scrobiculariae* has a reddish tint, can reach a length of 1·2 mm., the genital pore is at the end of the second fifth of the body, the ovaries are disposed longitudinally, and the embryos on hatching measure 0·08 mm. The adult lives in the intestine, as well as in the stomach, of the host.

P. cardii has frequently been described from cockles in Great Britain (for review, see Atkins[6]), but the species from *Scrobicularia* has not hitherto been recorded here. Examination of *Scrobicularia* from Whitstable in Kent recently revealed an occurrence of this parasitic Rhabdocoele. Altogether some forty animals were examined and eight parasites recovered from three of them. All the specimens were found in the intestine. They were red in colour, body-length 0·53–1·15 mm., with longitudinally placed ovaries. The genital pore was situated between 0·35 and 0·39 of the total body-length from the anterior end. All the specimens included capsules, none of which contained more than two eggs, and one specimen contained at least 54 embryos with well-developed eyes, many of them already free in the mesenchyme of the mother (Fig. 1). The largest of these embryos was 0·077 mm. long. These characters clearly identify the parasite as *Paravortex scrobiculariae* (Graff).

The presence in the intestine of a specimen in full production of advanced embryos illustrates a difference between the life-cycles of the two European

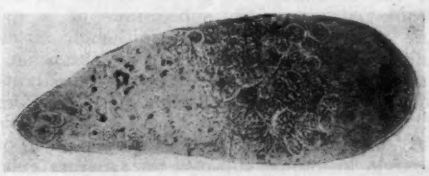

Fig. 1. *Paravortex scrobiculariae*. Adult containing embryos. (× 55)

species. Comparable adult stages of *P. cardii* only occur in the stomach of *Cardium*, and, although development of capsules may commence in the young forms as they pass along the intestine, these intestinal forms are essentially the dispersive and infective stages in the life-history. As Hallez observes[4], "une fois installés dans l'estomac de leur hôte, les parasites y achèvent leur vie sans émigrer de nouveau". The adult shown in Fig. 1 was recovered from the posterior end of the intestine where it traverses the pericardium. The parasite was wedged between two of the compacted, cylindrical, fæcal pellets of the host, and it is difficult to imagine how it would be able to maintain its position in the intestine, particularly in view of the extensive and vigorous ciliation of this part of the gut. In view of the large number of advanced embryos present in this individual, these considerations lend some support to the view put forward by Wahl, but disputed by Hallez, that simultaneous liberation of the embryos involves degeneration and death of the mother in this species, as has been established for *P. gemellipara*.

The number of *Scrobicularia* found to be harbouring the parasite at Whitstable was not great when compared with the 72 per cent infection at Naples and 55 per cent at Trieste found by Wahl, and the 55 per cent found by Hallez at Étaples. The American species was found to be rare in mussels from certain localities, with some evidence of a seasonal periodicity in numbers[7], and investigation of other populations of *Scrobicularia* in Britain may well reveal further and more intensive occurrences of this interesting parasite.

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European Foul Brood : a Disease of the Larval Honeybee (*Apis mellifera* L.) caused by a Combination of *Streptococcus pluton* (*Bacillus pluton* White) and *Bacterium eurydice* White

Results of preliminary experiments[1] have shown that European foul brood disease of the larval honeybee can be caused in bee colonies by spraying their brood with suspensions of *Streptococcus pluton* (*Bacillus pluton* White) and *Bacterium eurydice* White if the two organisms are grown together in mixed anaerobic culture; fifth subcultures of a mixed culture were usually virulent, although virulence diminished rapidly after further sub-cultivation. It was not possible to cause the disease by simultaneous inoculation with separate cultures of the two organisms. As there is a tendency for colonies of *S. pluton* and *B. eurydice* to grow within, or upon, each other on agar in anaerobic cultures, the separate cultures of each organism were subcultured five times to try to ensure the exclusion of the other. The results of these experiments showed that virulence was maintained by one or both organisms in mixed culture, but the possibility remained that only one of the organisms was pathogenic; its virulence may have been maintained by the growth of the other which may, *in vivo*, be a secondary invader of the diseased larva.

It was found later[2] that anaerobic growth of *B. eurydice* was considerably improved by the addition of fructose + glucose (or honey) to the culture medium; either sugar alone supported only feeble anaerobic growth. *B. eurydice* produced much acid when grown with the two sugars; this prevented the growth of *S. pluton* when a mixed culture of *S. pluton* and *B. eurydice* was subcultivated into a medium containing honey. Thus, the use of a honey-medium made it easier to ensure the separation of the two organisms in early subculture, and an experiment was made to test the pathogenicity of such cultures.

On May 5, 1957, a loop-full of the mid-gut contents of a larva with European foul brood disease was streaked on a plate of agar of the following constitution: 10 gm. glucose; 10 gm. yeast extract ('Difco'); 13·6 gm. potassium dihydrogen phosphate; 20 gm. agar; 1,000 ml. water; the *p*H was adjusted to 6·6 with potash and the medium was autoclaved for 20 min. at 10 lb./in.^{2} (116° C.). The plate was incubated at 35° in a McIntosh and Fildes jar which contained hydrogen 95 per cent (v/v) + 5 per cent (v/v) carbon dioxide. Colonies of *B. eurydice* were visible after 24 hr. and colonies of *S. pluton* after 2½ days. Single, well-isolated colonies of each organism were subcultured, each on a plate of the medium described above + 1·0 per cent (v/v) honey. *B. eurydice* grew vigorously after 24 hr., and a well-isolated colony was subcultivated into 150 ml. of broth of the honey-medium which became very turbid after 24 hr. Colonies of *S. pluton* were visible on the other plate after 2½ days; there were no visible colonies of *B. eurydice*, and a well-isolated colony of *S. pluton* was subcultivated into 150 ml. of broth of honey-medium. This broth was slightly turbid after 2 days; growth was heavy after 3 days. The bacteria were centrifuged from the broths and each deposit was suspended in 10 ml. of 30 per cent (w/v) sucrose syrup. A third suspension was made of a mixture of one-third of each of the two suspensions.

On May 17, 1957, each suspension was sprayed over the combs of one of three small bee colonies. The bee colonies were taken from an apiary, the colonies in which had never had European foul brood and showed no sign of disease during or after these experiments. The inoculated colonies were equal in size and were placed on separate sites, well out of range of drifting bees from each other or from any other bee colonies.

After 11 days, a few larvæ, dead or dying with European foul brood disease, were seen in the colony which had been sprayed with the mixed suspension containing *S. pluton* + *B. eurydice*; 6 days later, the disease was general. *S. pluton* and *B. eurydice* were re-isolated from the diseased larvæ. There was never any sign of the disease in the two colonies which had been inoculated with the separate suspensions of bacteria. These two bee colonies were again similarly inoculated with new isolates of the respective organisms, but no sign of disease appeared.

It seems certain that European foul brood of honeybees is caused by simultaneous infection with the two bacteria *S. pluton* and *B. eurydice*. When

pure cultures of *S. pluton* have been sprayed into healthy bee colonies, the organism has appeared to grow in coccal form in the mid-guts of the larvæ for a day or two afterwards; then, for a further day or so, diminishing numbers of thick rod-like bacteria only were found. These forms appeared similar to the aerobic form of *S. pluton* which can be cultivated *in vitro*[2]. The lumen of the mid-gut of the larval honeybee may not, therefore, be anaerobic. In a normal infection, *B. eurydice* may reduce oxygen tension enough to allow *S. pluton* to develop in coccal form as when a mixed culture of the organisms is grown with air in a closed bottle[2].

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Occurrence of the Muskrat in Hu Ma District, North-eastern China

The muskrat, *Ondatra zibethica* L., has been introduced into many parts of Europe since 1905 and into the U.S.S.R. in 1927.

Its occurrence in the Amur region or Hehlung Kiang, on the northern part of Manchuria or north-eastern China, was first reported by Shaw and Chu[1], based on two living specimens and three dead ones collected by Mr. Tsong of the Animal Products Co. in early summer of 1954. Later, in the spring of 1955, Mr. C. Chang made a special trip to Hu Ma district, where he collected twenty-one specimens. Still later, Mr. T. H. Lo obtained a few more specimens and made some observations in the same region in the summer of 1956 [2].

Hu Ma District lies on the southern bank of the Amur River. Its climate as a whole is rather cold. Winter is long, and air temperature may fall to − 46° or even − 49° C. Summer seems to be rather short and not very hot; the warmest weather in June, July and August being 35° C.

According to local information, individual muskrats have been observed in Hu Ma District for more than ten years. Due to the severe and long winter in this region, the shortness of growing season, and the lack of proper protection, the population of the animal increases rather slowly.

The coloration of the muskrat shows some variation. The head, neck and back of Hu Ma specimens are darker than the original stock. The size of both sexes, however, is smaller, largest specimens weighing only 2,200 gm.

The animal is chiefly nocturnal, but is also active in daytime, and can be seen in bright sunlight. Nest and tunnels are excavated underground and rather complex in nature. There is only one entrance to the nest. The largest colony so far observed contained fourteen individuals in a single burrow.

Like those which inhabit other parts of the world, the males are larger than the females. It is difficult to determine the sex, for it is necessary to examine the nipples (three or four pairs) or external genitalia. The animal breeds twice a year. The first litter appears from the end of May to the beginning of June and

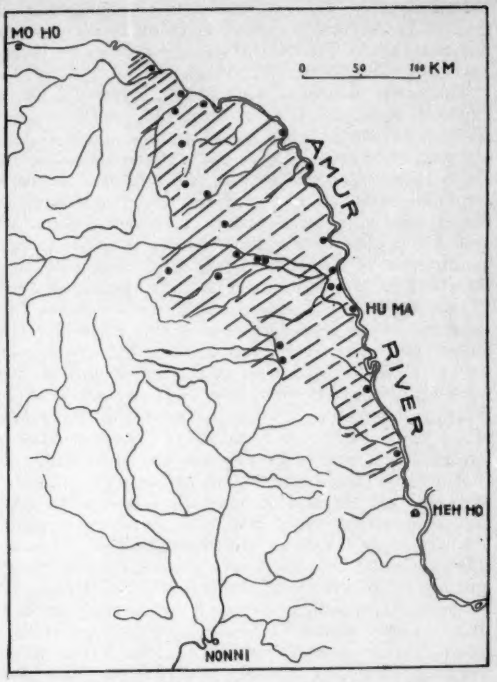

Fig. 1. The Amur region of north-eastern China. Dots indicate places of occurrence of the muskrat; shaded areas indicate their range

the second litter between July and August. The animal does not hibernate in winter, and is chiefly herbivorous. Aquatic plants are very rare during the coldest months, so the animal then lives mainly on fishes or other animals.

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Elephant Seals on the Antarctic Continent

The elephant seal (*Mirounga leonina* (L.)) has not previously been recorded in any numbers away from its known breeding grounds. These are antarctic and subantarctic islands from the South Shetlands to Macquarie and the Campbell Islands, extending north to Tierra del Fuego and the Falklands. The southernmost known breeding ground is King George Island in the South Shetlands, in about 62° S. South of this, stragglers are fairly common off north Graham Land in 64°–65° S. [1,2], and single individuals have been recorded in summer from Terre Adélie (66° 45′ S.) [3], Cape Denison (67° 0′ S.) [4], Scott Island (67° 24′ S.) [5], Cape Hallett (72° 25′ S.) [6] and McMurdo Sound (77° 40′ S.) [7]. A young male was seen on March 24, 1954, at Mawson (67° 36′ S.). There are also a few records of sightings in the pack-ice.

In February, 1957, a regular summer hauling-out ground for several hundred elephant seals was discovered in the Vestfold Hills, Australian Antarctic Territory, 68° 35′ S., 77° 58′ E.

This area contains about 300 square miles of exposed rock, ice-free in summer, with beaches suitable for these seals. During the establishment of the Australian National Antarctic Research Expeditions' Station 'Davis', a number of moulting elephant seals were found in the neighbourhood. Seven were seen on February 1, 37 on February 8 and 77 on February 19. Later, Robert Dingle, commander of the station, reported counts of more than 400 on March 6, more than 250 on April 2 and 17 on April 28. These counts were made on four beaches with a total length of about 1,300 ft. One female was seen in February but all the rest were males. Bachelor bulls were in the majority, but there were a number that could be classed as mature harem bulls; adolescents 2–4 yr. old made up 5 per cent of the total on March 6 and 25 per cent on April 2. Skulls, teeth and carcasses on the beach showed that it must have been visited regularly for a number of years. By the end of April the last seals to leave had to cross 5 miles of fast ice to reach open water.

There is no difference in date of moulting between these seals and more northerly populations. Although nothing is yet known of the behaviour of the sea-ice at the Vestfold Hills in spring, it is extremely unlikely that the beaches are ice-free in time for the breeding season (September–November). Even if the shores were ice-free, it is unlikely that the elephant seals would penetrate the wide belt of pack-ice farther north. It is much more probable that a small part of the large population breeding at Kerguelen and Heard Island goes south in summer. Since branded elephant seals from Heard Island have twice been reported at Marion Island, a distance of 1,614 statute miles, the 1,082 miles from Heard to the Vestfold Hills is well within their powers. The situation may best be compared with that at the South Orkneys[2], where the breeding population is very small but the summer population is about 10,000, and reflects a wide dispersal of elephant seals over suitable feeding grounds.

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The Freshwater Eel *Anguilla obscura* Gunther, 1871, in Southern Africa

On August 8 fifteen eels were collected in the Mgqakwebe River (27° 22′ E., 32° 50′ S.), a tributary of the Buffalo River, Cape Province. One specimen, a short-fin species 35·5 cm. in length and very dark in colour, differed in appearance from any of this group previously found. A subsequent detailed examination has shown this to be without doubt *Anguilla obscura* Gunther, 1871, a Pacific species not previously reported west of New Guinea and a notable discovery on the African continent.

In his revision of the genus *Anguilla* Shaw, Ege[1] examined Gunther's type of *obscura*, and detailed specifications are available for identification of this species. The characteristics of this specimen from the Buffalo River system have been found to fall within the range of those given for *Anguilla obscura* in every detail. The following critical evaluations were observed in the specimen now described: (*a*) length of intermaxillary-vomerine band of teeth, 73 per cent of the distance from the front margin of that band to the posterior end of the right maxillary band; (*b*) the distance between verticals through the anus and the origin of the dorsal fin, 2·4 per cent of the total length; (*c*) total number of vertebræ = 103. The gonads were not developed, and the sex could not be determined.

Whether this specimen of *Anguilla obscura* in the Buffalo River system is a stray or not can only be shown by future investigations. That in its larval life and metamorphosis it may have endured a most extensive migration is of far-reaching significance.

It has been shown that Indo-Pacific freshwater eels have several, presumably well-separated spawning areas[2], all of which are close to land, though only a few have been positively located. Larvæ of *Anguilla bicolor bicolor* McClelland and of *Anguilla mossambica* Peters, have definitely been found between the northern tip of Madagascar and the African mainland[3]. Elvers of the former, 5·0–6·0 cm. in length, have been collected near Dar-es-Salaam[3], and elvers of the latter, as well as those of *Anguilla marmorata* Quoy and Gaimard, from the rivers of Madagascar[1]. In consequence, for these African eels an area east of Madagascar has been suggested as a spawning ground. In the case of *Anguilla marmorata*, which is dominantly western Pacific in distribution, we can expect to find other spawning areas nearer its major distribution area.

In this connexion it is probably significant that young eels of all species migrating up the Buffalo River are variable in size, ranging from 10 to 22 cm. in length[4], an unusual feature if they belong to a single age-group. No specimens of migrating young eels of this type from the Buffalo River that I have examined are fully pigmented; on Strubberg's specification[5] they are elvers in the last stages of metamorphosis, which means that they can have been in fresh water only a very short time. The range in size can therefore not be explained by sojourn in fresh water, but more likely indicates an unusually long period, anything from 2 to 5 years, at sea—much longer than would be required for those elvers to travel from the vicinity of Madagascar to southern Africa. It may well be that a number of the elvers found migrating up the Buffalo River do not come from the same spawning ground as those reaching Madagascar, but from one possibly much more distant, which they may well share with other species such as *marmorata* and *obscura*.

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Maintenance *in vitro* of *Haplometra cylindracea*

DURING the past two years, attempts have been made in this laboratory to keep alive *in vitro* sterile trematodes of the species *Haplometra cylindracea* (Zeder, 1800) obtained by aseptic dissection from the lungs of frogs (*Rana temporaria*). Of the 338 frogs dissected to date, 194 were uninfected with this trematode and the remaining 144 frogs provided a total of 576 living flukes. One remarkable frog had 23 flukes in the left lung and 17 in the right lung; but the majority of infected frogs had either two or three flukes in each lung.

In previous work of this kind with *Fasciola hepatica* it was shown[1,2] that Hédon–Fleig is a valuable saline to use. In the present work it was used once more; but sodium dihydrogen phosphate was substituted for disodium hydrogen phosphate, with consequent alteration of the *p*H range from 8·4–8·8 to 8·2–8·4. In addition, a frog Ringer's solution with the following composition and *p*H range was used: sodium chloride 6·5 gm., potassium chloride 0·25 gm., calcium chloride 0·3 gm., sodium bicarbonate 1·2 gm. and distilled water 1,000 c.c.; *p*H 8·1–8·3. Both solutions were filtered as in previous work and both were used either with or without additions of D-glucose (0·5 per cent). *Haplometra cylindracea* continued to live in a fairly active condition in these solutions when kept at 20° C. for the periods specified as follows:

	Duration of culture period (days)	
	Ranges	Means
Hédon–Fleig − glucose	48–105	69
Hédon–Fleig + glucose	60–82	71
Ringer − glucose	50–88	68
Ringer + glucose	54–84	64

Thus, *H. cylindracea* remains alive under these simple conditions of culture for much longer periods than does *F. hepatica*, partly no doubt because of the lower temperature of incubation but also because of its smaller size. There seems to be no significant difference in periods of survival in Hédon–Fleig and Ringer's solutions with or without additions of glucose, whereas *Fasciola* will not continue to live for more than about 48 hr. in the absence of glucose, while in the presence of glucose it has been found to live under these conditions for as long as 34 days. In a sterile medium somewhat enriched with nutrients ('Bacto' beef extract 0·3 per cent, sodium chloride 0·5 per cent, 'Bacto' tryptose 1·0 per cent and D-glucose 0·5 per cent) and having a *p*H range of 7·2–7·4, twelve separately treated *Haplometra* continued to live for 57–110 days, with a mean period of 88 days. In all these experiments, as in those with *Fasciola*, histological examination of the fluke revealed abnormalities of spermatogenesis, but in *Haplometra* these first appeared much later and only after about five days of culture.

After dissecting out the compact testes of *Haplometra* it was easy to make permanent fixed and stained smears showing stages of spermatogenesis, and examination of these revealed some variability in the rate of meiotic division in the primary spermatocyte stage. The mean rate is fairly constant *in vivo* at about 24 divisions per 1,000 spermatocytes examined at random, and this falls only slightly to about 14 per 1,000 after 24 hr. of culture in dextrose broth, but it falls to zero in the Ringer's solution without glucose and to 4 per 1,000 in this saline with added glucose. An initial fall to 14 per 1,000 is seen after 4 hr. of culture in all the solutions employed, so that in dextrose broth the meiotic division-rate does not fall appreciably after 4 hr. for a further 20 hr., and there is some foundation for the statement that it does not fall below this figure for periods up to five days.

Both flukes freshly removed from their hosts and flukes which had been maintained in the Ringer's solutions with or without glucose and in dextrose broth were examined for glycogen deposits after freeze-drying. In fresh flukes glycogen is stored in the muscles and in the cells of the parenchyma. Flukes cultured in Ringer's solution plus glucose and in dextrose broth showed heavy deposits of glycogen in the muscles and only slightly reduced deposits in the parenchyma, but flukes cultured in the Ringer's solution without glucose showed practically no glycogen in the parenchyma, though deposits were still present in the muscles. Quantitative studies based on the photometric estimation of glucose by Nelson's method[3] showed clearly that glucose is abstracted from the medium by the flukes and that in Ringer's solution plus glucose and in dextrose broth the glycogen deposits are maintained at the *in vivo* level of 1·5 per cent wet weight for periods up to three weeks, but that in Ringer's solution without glucose the gross deposits of glycogen are substantially reduced to a mean of 0·8 per cent wet weight after one week. However, Warburg determinations show that the rate of respiration of flukes maintained in Ringer's solution plus glucose falls from a mean of 4·8 µl./mgm. dry weight per hr. at 25° C. to about one-half of this value after about two weeks.

It appears that *H. cylindracea* depends on aerobic respiration to a greater extent than do any other helminths so far studied[4]. It dies within 4 hr. under anaerobic conditions, but after shorter periods of anaerobiosis the oxygen debt incurred is completely repaid when the medium is placed in equilibrium with atmospheric oxygen. Experiments are now proceeding to determine the amount of increase in glucose uptake from solutions and to estimate lactic acid production by worms placed under anaerobic conditions.

Note added in proof: Recent estimates indicate that lactic acid production during a short period of anaerobiosis (2 hr.) is increased threefold.

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Colonial Differentiation between *Escherichia coli* B and *Escherichia coli* B/r

A GREAT deal of radiobiological research has been carried out on *Escherichia coli*, strain B, and its radiation resistant counterpart, *Escherichia coli*, strain B/r[1]. Aside from the fact that *E. coli* B/r demonstrates increased resistance to various physical and chemical agents[1–4] when it is compared to the more sensitive parental type, there is little else to distinguish one strain from the other.

It was recently noticed in our laboratory that *E. coli* B and *E. coli* B/r exhibited an unmistakable

difference in colonial morphology when either strain was plated on the surface of *A–C* agar[5], a medium commonly used in our laboratory and consisting of 1·0 per cent *N–Z*–Case (Sheffield), 1·0 per cent yeast extract ('Difco'), 0·2 per cent potassium hydrogen phosphate, 0·1 per cent glucose and 1·5 per cent agar. On the surface of this medium the colonies of the B/r strain appear with a smooth (*S*) outer edge, while the B strain takes on the classically rough (*R*) appearance with a highly serrated outer edge.

The experimental protocol in its entirety entails growing cultures of *E. coli* B and B/r for 19 hr. at 37° C. in test tubes containing 10 ml. of liquid medium that is identical in nutrient composition to the solid medium employed in the plating procedure. The cells are centrifuged, washed twice in 10 ml. aliquots of physiological saline and finally resuspended in 10 ml. of saline. An appropriate dilution of this cell suspension is made through a series of saline dilution blanks and the cells are plated on the surface of the solid media. (These agar plates are poured and dried at 37° C., 48 hr. prior to use.) After an incubation period of 24 hr. at 37° C., an examination of the colonies on the plate reveals the characteristic *S–R* differentiation.

Attempts were made to observe this difference among colonies of the two strains that had been cultured on media normally associated with these organisms; this phenomenon could not be demonstrated with nutrient agar ('Difco') or the *M*-9 medium of Anderson[6].

Since capsular formation is very often related to colonial morphology, the significance of these data would seem to imply that the radiation resistance of *E. coli* B/r may very well be related to a capsular property of this organism.

Leonard N. Zimmerman

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[1] Witkin, E., *Genetics*, **32**, 221 (1947).
[2] Bryson, V., *J. Bact.*, **56**, 423 (1948).
[3] Bryson, V., *Bact. Proc.*, 15 (1949).
[4] Bryson, V., and Davidson, H., *Proc. U.S. Nat. Acad. Sci.*, **37**, 784 (1951).
[5] Charles, R. L., and Zimmerman, L. N., *J. Bact.*, **71**, 611 (1956).
[6] Anderson, E. H., *Proc. U.S. Nat. Acad. Sci.*, **32**, 120 (1946).

Sexual Dimorphism in Labiatae

In a recent communication, Baker[1] directed attention to the difference in size of pistillate and hermaphrodite flowers in gynodiœcious and gynomonœcious plants and suggested that the hormonal control of sex-expression might be connected with the level of auxin activity in the developing flower bud. In the course of genetical studies of gynodiœcy in members of the Labiatae, I have made some observations on the orign of this size difference in the case of *Glechoma hederacea* L.

Some individuals of this species produce female flowers only; others are gynomonœcious, the proportion of female flowers to hermaphrodite varying with the stock and also with the season. The female flowers on predominantly hermaphrodite plants are smaller than the hermaphrodite flowers and are equal in size to those on purely female individuals. Occasional flowers are found which have one, two or three aborted anthers and these are intermediate in size between the female and the complete hermaphrodite flowers.

Table 1. Effect of Removal of Anthers from Hermaphrodite Flower Buds on the Lengths of the Mature Corollas

No. of anthers removed	0	1	2	3	4	Natural female
No. of flowers measured	10	10	35	9	8	3
Mean length of mature corollas in mm.	16·5	15·6	14·3	13·2	11·8	11·3

Artificial emasculation of hermaphrodite flowers in bud reduces the size of the corollas, in proportion to the number of anthers removed. When all four anthers are removed, the corolla does not grow beyond the size of the naturally occurring female flowers (Table 1). An associated effect is that in emasculated, as in natural female, flowers the stigma opens immediately after the opening of the corolla, whereas in complete hermaphrodite flowers it remains closed until after anthesis.

It seems reasonable to suppose that the growth of the corolla is influenced by a hormone produced in the anthers, but I have not yet succeeded in replacing the anthers effectively to prove this. The application to emasculated hermaphrodite flower buds of β-indolylacetic acid in lanolin at a range of concentrations 1,000–10 p.p.m. did not stimulate the growth of the corolla. Strong inhibition of corolla growth occurred when 1,000 p.p.m. of β-indolylacetic acid were used and some inhibition was apparent with 500 p.p.m. of β-indolylacetic acid. It is hoped to extend this work during the next flowering season.

Such a hormone must be released post-meiotically. The data given in Table 1 were obtained from buds emasculated when about 5 mm. long, the critical stage for effective treatment being a length of about 7 mm., whereas meiosis is completed when the buds are only about 1 mm. long. This seems to correspond with the observations of Wittwer[2], who investigated the production of growth hormone in the staminate flowers of corn. He found that this occurred only after the onset of meiosis, the greatest concentration being attained ten days to two weeks after the beginning of synapsis. In *Glechoma*, female flower-buds 5 mm. long do not contain anthers, so that the determination of the mature corolla-length must occur at a stage later than that of the determination of the sex of the flower.

Baker stated that in at least some gynodiœcious members of the Labiatae, the abortion of the anthers is associated with a dwarfing of the plant in all its aerial parts. This does not appear to be a general manifestation. For example, in *Thymus vulgaris* L., female and hermaphrodite plants in the progeny of a cross female × hermaphrodite are equal in size, whereas selfing hermaphrodite plants produces much smaller hermaphrodite offspring (apparently a heterotic effect) (Table 2). I have not noticed any dwarfing of the females in the other species which I have studied (*Thymus serpyllum* L., *T. drucei* Ronn., *T. pulegioides* L., *Salvia verticillata* L. and *S. pratensis*

Table 2. Comparison of the Size of Female and Hermaphrodite Plants of *Thymus vulgaris* L.

Parents	♀ × ☿		☿ − *S*
Sex	♀	☿	☿
No. of plants measured	14	12	35
Mean lengths of main axis in cm.	27·0	28·2	17·7

L.). The effect on corolla size of the hypothetical anther hormone of *Glechoma* is evidently quite localized since small female and large hermaphrodite flowers occur close together in the same inflorescence. However, it was not found possible to destroy the symmetry of the corolla by removing two anthers asymmetrically.

In conclusion, it seems to me that the reduction in size of the pistillate flowers is a secondary sexual characteristic, resulting directly from the loss of the anthers, and not necessarily connected in any more immediate way with the factors which determine the sex of the flowers.

I am much indebted to Prof. D. Lewis for helpful discussion.

AUDREY PLACK

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Keele, Staffs. Oct. 15.

[1] Baker, H. G., *Nature*, **180**, 614 (1957).
[2] Wittwer, S. H., Univ. of Missouri Coll. of Agric. Res. Bull. 371 (1943).

Germinating Spores in the Rhynie Chert

A SMALL loose block of Rhynie Chert (Scottish Middle Old Red Sandstone) has been found to contain a number of isolated spores which appear to have been germinating at the time when the onset of conditions favouring their preservation occurred. In some cases it is clear that development had only just commenced, the spores having split open and produced small sac-like outgrowths in which no evidence of structure can be distinguished (Fig. 1*a*). A few specimens have been obtained, however, which probably represent slightly later stages, and in some of these, the outgrowths seem to be composed of thin-walled cells, although the possibility cannot be entirely excluded that they may be merely artefacts resulting from shrinkage or re-arrangement. The largest and best-preserved specimen found so far has an overall length of about 0·5 mm., the distal end of the rather narrow outgrowth showing a clearly defined multicellular pattern although this can be recognized discontinuously to the basal portion where it emerges from the spore. Owing to its obliquity in the matrix, it has not proved possible to obtain a satisfactory photograph, but its form is generally similar to that of the specimen shown in Fig. 1*b*. While the outgrowth in this case is slightly smaller and rather badly decayed, the tripartite splitting of the spore is clearly visible. Another specimen showing this feature together with evidence of possible cellular structure appears as Fig. 1*c*, part of the (? incomplete) outgrowth being shown at a higher magnification in Fig. 1*d*.

While there can be no certainty regarding the identities of any of the spores, size measurements, taken in conjunction with the recorded flora of the deposit[1], make it not unlikely that some of them, at least, may have been the products of one of the known vascular plants. A few spores, the maximum diameter of which prior to splitting has been estimated at about 67μ, compare fairly closely both in size and appearance with those of *Rhynia major* (65μ for unshed spores, Kidston and Lang[1]). Most of the spores showing evidence of development, however, although generally similar in form to those of *Rhynia*, are appreciably larger, being about 81μ in diameter. While there is evidence to suggest that these were formed in tetrads, the plant which produced them is as yet unknown.

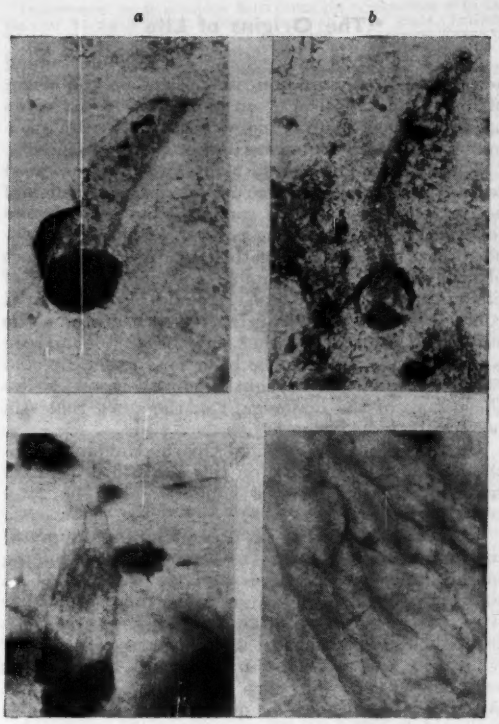

Fig. 1. *a*, Germinating spore (? of *Rhynia major*) (× *c.* 190); *b*, spore of similar size with more extensive outgrowth (× *c.* 98); *c*, spore estimated to be about 81μ in diameter with outgrowth (× *c.* 95); *d*, part of the above outgrowth showing evidence of possible cellular structure (× *c.* 375). All figures are reproduced from untouched photographs

Associated with the spores in the block are abundant fragmentary remains of *Algites* (*Palaeonitella*) *cranii* the occurrence of which, at certain levels in the deposit, has been interpreted by Kidston and Lang as suggesting the existence of highly aquatic and probably submerged conditions. There are no certain means of knowing, however, whether it was under such conditions that germination took place or whether the spores, having germinated elsewhere, were carried into the positions which they finally occupied during a period of inundation at a late stage prior to petrifaction.

It seems reasonable to suppose that the outgrowths represent early stages in the development of the gametophyte generation of certain Middle Devonian plants, some, if not all, of which may well have been Psilophytes. While those found up to the present have been, at the best, imperfectly preserved and of uncertain identity, their presence in the chert increases the hope that something may yet be known of the adult prothallia of the early land plants of the Rhynie deposit.

A fuller account may be published elsewhere, when the examination of the remaining material has been completed.

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Cardiff. July 20.

[1] Kidston, R., and Lang, W. H., *Trans. Roy. Soc. Edin.*, **51**, 2 (1917–21).

"The Origins of Life"

N. W. Pirie's characteristic and entertaining account of the symposium in Moscow on the origin of life mainly consists of an exposition of his views on the subject and a metaphysical criticism of a minor part of my own contribution to the discussion.

The scientific value of the symposium lay, it seemed to me, in the fact that so many distinguished and active scientists in fields ranging from astrophysics to genetics, with a strong central weighting in biochemistry, had come together to discuss a subject of such wide scope and importance as the origin of life on the Earth. It is true that most of the prepared contributions had only an incidental bearing on the subject, but taken together they began to build up a picture which can be the basis for further directed research. They also brought out by their weaknesses the nature of the major gaps in the story that still need to be filled.

On the whole, the original Oparin–Haldane hypothesis of evolution of life on this Earth in a primary reducing atmosphere was supported by the later contributions.

Urey, who could not be present himself, summed up in favour of a primitive atmosphere containing mainly nitrogen and hydrocarbons with ammonia mostly dissolved in sea water. Miller reported further work on the synthesis of amino- and vegetable-acids from such simple molecules, which has been largely confirmed and extended by Terenin, Pavlovskaya and Passynsky, who also used ultra-violet light. Asymmetric syntheses on quartz catalysts were also reported by Klabunowski.

On the next and critical stage of polymer formation, there was an interesting paper by Akabori on the polymerization of amino-acetonitrite on clay to form polyglycine and the subsequent introduction of other amino-acid side-chains. This was about as far as the synthetic approach from simple molecules had progressed, though the work of Oparin and his school on reactions in coacervate drops is suggestive of the conditions of the next stage of Pirie's 'eobionts'.

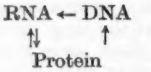
The rest of the discussions turned on the reverse approach, by analysis of existing biochemical processes in a variety of organisms. Despite Pirie's criticisms of the limitation this implies to the more successful mechanisms, it is unfortunately the only way open to us until we get to other planets. We had, on the most general question of the evolution of metabolism, an important paper by Prigogine on the thermodynamics of cyclic biochemical systems and of their evolution from simpler forms. Other ideas on the open character of organic metabolism were furnished by Broda and Mitchell.

I put forward a suggestion of how the apparent improbability of the enormous complexity of biological structures could be understood in terms of the formation of a sequence of structural units, such as macro-molecules, fibres and membranes, determined by the nature of their progressively weaker ultimate binding forces, each including all the smaller and more tightly bound lower structures. The functions of such structures in cell metabolism was well brought out in the paper by Sissakian.

In the field of biochemical evolution, Calvin brought forward a general hypothesis for the production of catalytic activity from progressively more complicated substances up to the present-day protein enzymes. Nicolaev provided some experimental evidence for this from the catalase-like activity of certain copper complexes.

On the evolution of proteins and enzymes, we had interesting papers from Šorm and Hoffmann-Osterhof showing the persistence of common features pointing to an earlier peptide stage. Straub provided further evidence in experiments that seemed to show that the synthesis of proteins in liver cells proceeds in two stages, first that of a common basic protein and then the addition of a specific terminal grouping conferring on it specific—enzymic or antibody—character.

The two other major biochemical activities, those of energy transfer and control of reproduction, seem to be carried out by the same groups—the nucleotides as coenzymes, and the polynucleotides or nucleic acids as basic genetic material. There was naturally much discussion of the nucleic acids, and their role in stabilizing biochemical reaction patterns, at the symposium, particularly in the contributions of Chargaff on the relations of proteins and nucleic acids, and in those of Fraenkel-Conrat and Schramm on specific protein synthesis by viruses, which I did not find as irrelevant to the subject as did Pirie. At the moment we have to consider the triad of mutual synthesis :



but this cannot have been the original state, and it is one of the major problems of biopœsis to find what were its antecedents.

On biochemical evolution there was general agreement that the Pasteur effect implied, as Oparin had first suggested, the priority of fermentative over oxidative cycles in the evolution of life, a point well brought out in Aubel's paper. It was also dealt with in an impressive paper by Braunstein on the evolution of nitrogen metabolism.

Closely connected with this is the question of photosynthesis, which was the means of liberating the molecular oxygen necessary for oxidative cycles. Here a series of interesting papers, especially those of Reid, Oda, Krasnovski, Sorokin and Sabozhnikow, indicated that before the chlorophyll-operated oxygen-liberating photosynthesis, there was one operating photocatalytically through simpler porphyrins and producing mainly molecular sulphur or sulphur compounds as some bacteria do to-day. Here Pirie is not quite fair in his claim that really primitive types were not studied, though it is now clear that there is much more to be learned in this field.

Nearly all the papers presented belonged or fitted in with the now almost orthodox scheme of biopœsis, including those as far removed as Pauling's on the relation of blood-group mutations by minor protein molecule changes. However, one interesting heresy appeared in the paper by Fox on the hydrothermal production of many enzymic reactions, suggesting that life had originated not in a cold but a nearly boiling ocean, to-day represented only by hot springs.

I hope these remarks may do something to enlarge Pirie's view of the symposium, but they still are far from doing justice to the wealth of information presented and the interesting discussions that ensued. However, in some months time scientists will have the opportunity to judge for themselves by the publication in several languages of the Proceedings of the Symposium.

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FORTHCOMING EVENTS

(Meetings marked with an asterisk • are open to the public)

Monday, December 2

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 5 p.m.—Mr. R. V. Leedham: "Junction Transistors and their Application to Switching Circuits".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. H. J. Eysenck: "The Confirmation of Hypotheses in Psychology".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the LONDON SECTION of the SOCIETY OF CHEMICAL INDUSTRY, at the Society of Chemical Industry, 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Prof. D. M. Newitt, F.R.S.: "High Pressure Reactions".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Dr. D. C. Martin: "International Geophysical Year".

Tuesday, December 3

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (at 14 Belgrave Square, London, S.W.1), at 10.30 a.m.—Water Meeting.

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. M. J. Gattiker: "Shell Gasification Process and its Application to Industry".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. August Knobel: "Snow Clearance Problems in Switzerland".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT and RADIO SECTIONS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Scientific Papers.

UNIVERSITY OF LONDON (at the Royal College of Science, South Kensington, London, S.W.7), at 5.30 p.m.—Prof. D. H. R. Barton: "Some Modern Trends in Organic Chemistry" (Inaugural Lecture).

Wednesday, December 4

POWDER METALLURGY JOINT GROUP of the IRON AND STEEL INSTITUTE and the INSTITUTE OF METALS (at Church House, Great Smith Street, London, S.W.1), at 10.30 a.m.—Inaugural Meeting. Dr. Ivor Jenkins: "Recent Developments in Powder Metallurgy"; followed by a discussion on "Developments in the Production and Quality of Metal Powders".

BRITISH COMPUTER SOCIETY (at the Northampton College of Advanced Technology, St. John Street, London, E.C.1), at 2.30 p.m.—Dr. D. J. Wheeler: "The EDSAC II Order Code—Some of the Reasons Underlying its Choice".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. Frank Wokes: "Some Nutritional Aspects of Vitamin B_{12}".

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. E. J. Lawton: "The Manufacture of Town Gas from Liquid or Gaseous Fuels".•

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. D. Downs: "Recent Engine Developments in Relation to Fuels and Lubricants".

INSTITUTE OF PHYSICS, EDUCATION GROUP (at 47 Belgrave Square, London, S.W.1), at 6 p.m.—Mr. F. I. G. Rawlins: "Physics and Æsthetics".•

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON GRADUATE AND STUDENT SECTION (at Savoy Place, London, W.C.2), at 6.30 p.m.—Mr. W. H. Dunkley: "Man/Machine Relationships".

SOCIETY FOR ANALYTICAL CHEMISTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Discussion on "Standardization" opened by Mr. R. C. Chirnside, Mr. L. S. Theobald, Dr. J. Haslam and Mr. G. Ingram.

ROYAL SOCIETY OF MEDICINE, SURGERY SECTION (at 1 Wimpole Street, London, W.1), at 8 p.m.—Trans-Atlantic Discussion—"Advances in Chemotherapy of Cancer".

Thursday, December 5

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 11 a.m.—Discussion on "Parity Conservation" opened by Prof. R. E. Peierls, F.R.S.

UNIVERSITY OF LONDON (at the Institute of Obstetrics and Gynæcology, Chelsea Hospital for Women, Dovehouse Street, London, S.W.3), at 4.30 p.m.—Dr. G. I. M. Swyer: "Intersex".

INSTITUTION OF NAVAL ARCHITECTS (in the Weir Lecture Hall, 10 Upper Belgrave Street, London, S.W.1), at 4.45 p.m.—Dr. R. W. L. Gawn: "Aspects of Propellers for the Royal Navy" (to be read by Mr. R. N. Newton) (Parsons Memorial Lecture).

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Prof. G. Macdonald: "The Conquest of Malaria".

INSTITUTE OF REFRIGERATION (at the Junior Institution of Engineers, Pepys House, 14 Rochester Row, Westminster, London, S.W.1), at 5.30 p.m.—Mr. G. C. Eddie: "The Development of a Quick-Freezing Plant for Distant-Water Trawlers".

INSTITUTION OF ELECTRICAL ENGINEERS (in conjunction with the BRITISH NUCLEAR ENERGY CONFERENCE, at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. J. V. Dunworth: "Advanced Types of Power Reactors".

SIR THOMAS MIDDLETON MEMORIAL TRUST (in the Auditorium, The Wellcome Building, 183 Euston Road, London, N.W.1), at 5.30 p.m.—Dr. Alan Robertson: "Modern Trends in Animal Breeding"• (Fifth Middleton Memorial Lecture).

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. R. J. W. Rees: "Experimental Approach to the Problems of Resistance to Tuberculosis".• (Last of fifteen lectures on "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation.)

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (at 15 Belgrave Square, London, S.W.1), at 6.15 p.m.—Meeting on "The Microbiology of Meat". Dr. M. Ingram: "The Importance of *p*H in Meat Microbiology"; Dr. Betty C. Hobbs: "Characteristics of Heat-Resistant *Clostridium welchii* in Carcass Meat".

WOMEN'S ENGINEERING SOCIETY, LONDON BRANCH (at the Central Electricity Authority Headquarters, Winsley Street, London, W.1), at 6.45 p.m.—Meeting on "The Radio Telescope". (Speaker from the Cavendish Laboratory, University of Cambridge.)

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the BATTERSEA COLLEGE OF TECHNOLOGY CHEMICAL SOCIETY, at the Battersea College of Technology, Battersea Park Road, London, S.W.11), at 7 p.m.—Prof. R. S. Nyholm: "The Modern Approach to Inorganic Chemistry in Schools, Colleges and Industry".

Friday, December 6

SOCIETY OF DYERS AND COLOURISTS, LONDON SECTION (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Mr. J. P. Gill: "Colour in Writing and Copying".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. K. G. A. Hammer: "Problems in Supplying Laboratory Chemicals".

INSTITUTION OF MECHANICAL ENGINEERS, INTERNAL COMBUSTION ENGINE GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Are Crankshaft Torsional Vibration Problems Things of the Past?"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Mary Woodall: "Gainsborough's Landscape Drawings".

Saturday, December 7

ASSOCIATION OF AGRICULTURE; and the BRITISH AGRICULTURAL HISTORY SOCIETY (at the Institute of Education, University of London, Malet Street, London, W.C.1), at 11 a.m.—Conference.

BRITISH MYCOLOGICAL SOCIETY (at the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 12 noon—Annual General Meeting. At 2.30 p.m.—Dr. C. J. Hickman: "Phytophthora—Plant Destroyer" (Presidential Address).

BRITISH INTERPLANETARY SOCIETY (in the Tudor Room, Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Dr. G. Fielder: "The Physical Nature of the Surface of the Moon".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT EXPERIMENTAL OFFICER (with a degree in botany with one or more of the following: chemistry, physics or mathematics, as supporting subjects) at Merlewood Research Station, Grange-over-Sands, Lancashire, for work on woodland ecology with particular reference to plant/soil relationships—The Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S.W.1 (December 6).

ADVISORY OFFICER (with a degree in engineering or science and experience of dairy processing and manufacture) IN DAIRY ENGINEERING—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (December 10).

DEPUTY DIRECTOR (with high qualifications, preferably in physics, mathematics or engineering, with a breadth of experience and some distinction in research and in the direction of research, either in the academic field or in Government or industrial research) OF THE NATIONAL PHYSICAL LABORATORY, Teddington (D.S.I.R.)—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4781/57 (December 12).

ASSISTANT EXPERIMENTAL OFFICER (with an ordinary degree or diploma in botany or agriculture)—The Secretary, Scottish Plant Breeding Station, Pentlandfield, Roslin, Midlothian (December 14).

LECTURER IN THEORETICAL PHYSICS—The Secretary, Birkbeck College (University of London), Malet Street, London, W.C.1 (December 14).

LECTURER (preferably with a veterinary qualification and some teaching experience) IN THE DEPARTMENT OF VETERINARY PHYSIOLOGY, Royal (Dick) School of Veterinary Studies—The Secretary, The University, Edinburgh (December 14).

PLANT PHYSIOLOGIST (with a first- or good second-class honours degree in botany and preferably some research experience and a knowledge of physics and its application in biology) IN THE BOTANY DEPARTMENT, to work on water relations of plants in connection with studies of growth of field crops under irrigation—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting 1051/9 (December 14).

CHIEF TECHNICIAN IN THE DEPARTMENT OF CHEMISTRY, University College of Ghana—The Assistant Registrar (London), University College of Ghana, 29 Tavistock Square, London, W.C.1 (December 16).

SOIL SURVEYORS with the New South Wales Department of Agriculture for duties which include carrying out soil surveys in any part of New South Wales, the preparation of data and draft maps from surveys, laboratory work, etc.—The Agent General for New South Wales, 56 Strand, London, W.C.2 (December 20).

LECTURER IN EDUCATION at the University of Tasmania, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 31).

OFFICIAL FELLOW or LECTURER (preferably able to teach inorganic chemistry, physical chemistry or physics), to share in the teaching of the final Honour School of Natural Science—The Principal, St. Hilda's College, Oxford (December 31).

STAFF TUTOR IN NATURAL HISTORY in the Department of Extra-Mural Studies—The Secretary, The Queen's University, Belfast (January 1).

LECTURER IN MICROBIOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 6).

JUNIOR RESEARCH FELLOW (with a good honours degree in zoology or entomology) IN THE DEPARTMENT OF ZOOLOGY, University College of Rhodesia and Nyasaland, to undertake work on a problem of locust physiology under the direction of the Head of the Department—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (January 7).

SENIOR RESEARCH ASSISTANTS (honours graduates in engineering or physics) IN THE DEPARTMENTS OF CIVIL AND MECHANICAL ENGINEERING, for work in the fields of the fatigue of metals and photoelasticity—The Registrar, The University, Nottingham (January 15).

DEMONSTRATOR IN THE DEPARTMENT OF GEOLOGY—The Secretary of the Appointments Committee, Department of Geography, The University, Downing Place, Cambridge (January 31).

LECTURER IN ANTHROPOLOGY IN THE DEPARTMENT OF GEOGRAPHY—The Secretary, The University, 38 North Bailey, Durham (January 31).

ROYAL SOCIETY RESEARCH FELLOW IN CYTOLOGY and/or CYTOCHEMISTRY, with special reference to malignant cells—The Assistant Secretary, The Royal Society, Burlington House, Piccadilly, London, W.1 (February 15).

COX CHAIR OF ANATOMY—Joint Clerk to the University Court (University of St. Andrews), Queen's College, Dundee (February 28).

ASSISTANT EXPERIMENTAL OFFICER (preferably with experience of chromatography, use of radioactive isotopes and a variety of techniques of chemical analysis), for biochemical research on amino-acids and proteins of plants—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

ASSISTANT LECTURER (Grade B) IN CHEMISTRY—The Registrar, Hatfield Technical College, Roe Green, Hatfield, Herts.

ASSISTANT LECTURER (with a degree or diploma in horticulture) IN HORTICULTURE—The Registrar, Massey Agricultural College (University of New Zealand), Palmerston North, New Zealand.

ASSISTANT LIBRARIAN—The Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks.

BIOCHEMIST, Basic Grade, to work under the direction of the Consultant Chemical Pathologist—The Chief Administrative Officer, The United Sheffield Hospitals, West Street, Sheffield 1.

BIOLOGIST (male or female, with a bias towards plant pathology, and preferably postgraduate experience) to continue investigations into the fungal diseases of turf and allied matters—The Secretary, The Sports Turf Research Institute, Bingley, Yorkshire.

EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER (woman graduate in chemistry or domestic science) IN THE DOMESTIC FOOD PRESERVATION SECTION—The Secretary, Research Station (University of Bristol), Long Ashton, Bristol.

EXPERIMENTAL OFFICER (preferably with H.N.C. or a degree in electrical engineering, or at least H.S.C. (Science) or equivalent, and previous experience in one of the following fields: instrumentation; electrical circuitry design; high speed oscillography), to work in a Section engaged in the preparation, assembly and testing of electronic and electro-mechanical weapon equipment for U.K. and overseas trials—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. No. A.1470/34.

GRADUATE, to take part in research work in the field of bacterial viruses—The Secretary, Guy's Hospital Medical School, London Bridge, S.E.1.

JUNIOR BIOCHEMIST, to work on human plasma proteins in the Blood Products Laboratory—The Secretary, The Lister Institute of Preventive Medicine, Elstree, Herts.

LECTURER (with a university degree in either physics or electrical engineering and teaching and/or industrial experience) IN PHYSICS or ELECTRICAL ENGINEERING (LIGHT CURRENT)—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex.

LECTURER (with an honours degree or equivalent, and with suitable industrial or research experience) IN CHEMISTRY at Coventry Technical College—The Director of Education, New Council Offices, Coventry.

METALLURGIST or METALLURGICAL CHEMIST (graduate, preferably Ph.D.), to join in fundamental research on surface reactions—The Director, Arthur D. Little, Research Institute, Inveresk, Midlothian.

PRINCIPAL RESEARCH OFFICER (with a good honours degree in chemistry or agricultural chemistry and considerable postgraduate research experience which must include administration and organization of a research unit) IN THE DEPARTMENT OF AGRICULTURE, Western Region of Nigeria, to take charge of the Chemistry and Soils Division which is responsible for soil survey, classification and analysis work; and soil fertility and plant nutrition investigations with particular reference to cocoa and general agricultural chemistry—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/420/017.

RESEARCH ASSISTANT (with a qualification in chemistry, biochemistry or physiology, and preferably experience in analytical or physical methods) IN BIOCHEMISTRY, for research on serum lipoproteins—Dr. W. G. Dangerfield, Pathology Department, North Middlesex Hospital, Edmonton, London, N.18.

RESEARCH ASSISTANT (with at least B.Sc. (special chemistry) or B.Sc. (general) with chemistry as one subject) IN THE MEDICAL UNIT, to work on problems of intermediary metabolism in man—The Secretary, St. Bartholomew's Hospital, Medical College, London, E.C.1.

RESEARCH ASSISTANTS (honours graduates) IN CHEMISTRY—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18.

RESEARCH ASSISTANTS (with H.N.C. or equivalent qualification), to join a team working on the efficient use of existing forms of energy and fuel in the iron and steel industry, and the introduction of new forms of energy and new techniques in this field—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting F.T.4.

RESEARCH OFFICER (female, with an honours degree in bacteriology, microbiology or zoology)—The Secretary, The Research Institute (Animal Virus Diseases), Pirbright, Surrey.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with a veterinary qualification or a first- or second-class honours degree in a biological subject) IN THE DEPARTMENT OF PARASITOLOGY, for research on the ecology of parasitic worms in sheep—The Secretary, Moredun Institute, Gilmerton, Edinburgh 9.

TECHNICIAN (with A.I.M.L.T. or similar qualification), for biological research work—H. E. H. Jones, Courtauld Institute of Biochemistry, The Middlesex Hospital, London, W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Edinburgh School of Agriculture; Edinburgh and East of Scotland College of Agriculture. Calendar for 1957–1958. Pp. 98. (Edinburgh: Edinburgh School of Agriculture; Edinburgh and East of Scotland College of Agriculture, 1957.) 1*s*. [189

The Conservation of Natural Resources: a Series of Lectures delivered at the Institution of Civil Engineers. Pp. 150+4 plates. (London: Institution of Civil Engineers, 1957.) 17*s*. 6*d*.; (7*s*. 6*d*. to members). [189

University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, for the year 1956. Pp. 180+11 plates. (Long Ashton, Bristol: Agricultural and Horticultural Research Station, 1957.) 15*s*. [189

The Registrar General's Statistical Review of England and Wales for the year 1955. Part 3: Commentary. Pp. xiii+274. (London: H.M. Stationery Office, 1957.) 11*s*. net. [189

Agricultural Research Council. Index of Agricultural Research, 1957. Pp. xiv+189. (Cambridge: At the University Press, 1957. Published for the Agricultural Research Council.) 12*s*. 6*d*. net. [189

Other Countries

Republic of the Sudan. Annual Report of the Government Analyst for the year 1955–56. Pp. 25. (Khartoum: Wellcome Chemical Laboratories, Ministry of Health, 1957.) [189

Bulletin of the American Museum of Natural History. Vol. 112, Article 5: A Study of the Classification of the More Primitive Non-Parasitic Anthophorine Bees (Hymenoptera, Apoidea). By Charles D. Michener and Jesus S. Moure. Pp. 395–452. (New York: American Museum of Natural History, 1957.) 1 dollar. [189

United States Naval Observatory. Circular No. 78: The Total Eclipse of October 2, 1959—Path of Total Phase in the United States. By Simone Daro Gossner. Pp. 7. Circular No. 79: Positions, Areas, and Counts of Sunspots, January, 1957. By Winifred Sawtell Cameron. Pp. 8. (Washington, D.C. United States Naval Observatory, 1957.) [189

Jamaica. Annual Report of the Department of Agriculture for the year ended 31st December, 1955. Pp. 1+74+6 plates. (Kingston: Government Printer, 1956.) 4*s*. [189

Connecticut Agricultural Experiment Station, New Haven. Circular 196: Highway Post Survey—a 1956 Progress Report. By Henry W. Hicock and A. Richard Olson. Pp. 12. Circular 197: The Forage Insect Problem. By R. J. Quinton. Pp. 14. Circular 198: Double-Cross Hybrid Corn: a Story of Small Plots and Big Men. Pp. 22. Circular 199: Pests of Ornamentals: Reports on Control Experiments. Dogwood Borer. By John C. Schread. Pp. 5. Circular 200: Systematic Insecticides to Control Mealybug, Scale, Aphids, Cyclamen Mite on Ornamentals. By John C. Schread. Pp. 18. Circular 201: Thrips on Privet and other Insects on Ornamentals. By John C. Schread. Pp. 11. Circular 202: Iris Borer and Its Control. By John C. Schread. Pp. 7. (New Haven, Conn.: Connecticut Agricultural Experiment Station, 1956 and 1957.) [199

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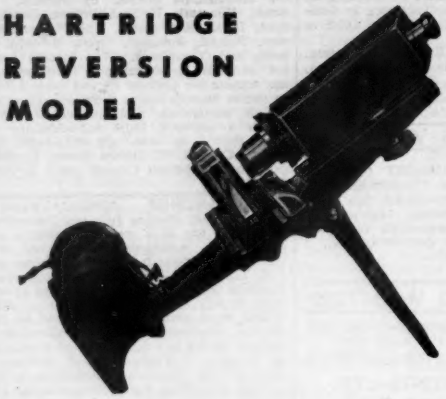

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